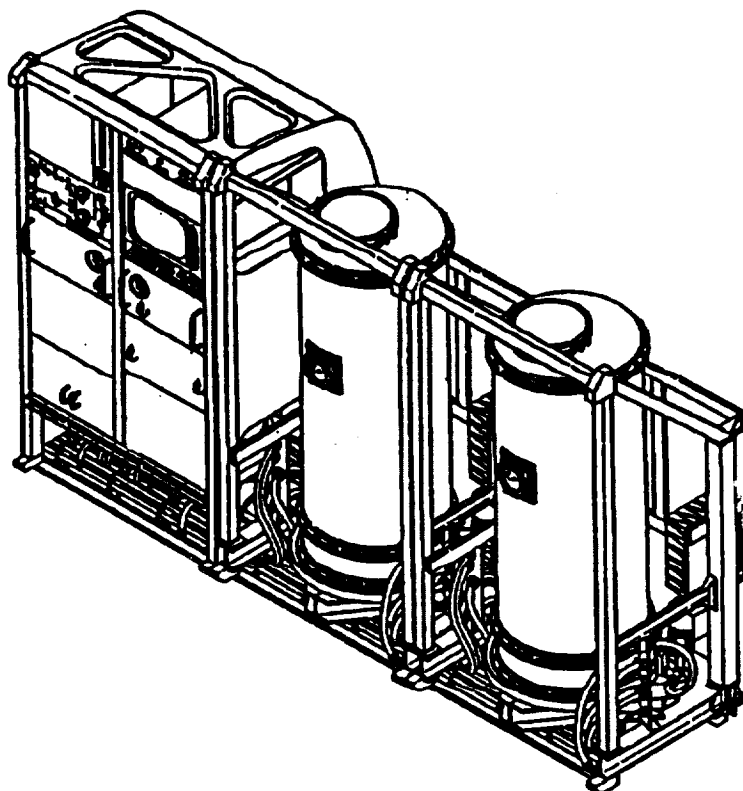


SPACE STATION FURNACE FACILITY

Program Cost Estimate



DR-6
May 1992

Volume III
Final Study Report of
Space Station Furnace Facility
Contract No. NAS8-38077

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COST ESTIMATE (Teledyne Brown
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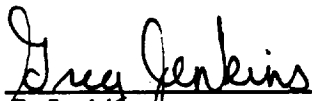
SPACE STATION FURNACE FACILITY

PROGRAM COST ESTIMATE

Contract No. NAS8-38077

DR-6

May 1992
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ABBREVIATIONS AND ACRONYMS

ATP	Authority To Proceed
CGF	Crystal Growth Furnace
CoDR	Conceptual Design Review
COTR	Contracting Officer's Technical Representative
DR	Data Requirement
FM	Furnace Module
GCEL	Ground Control Experiment Laboratory
GSE	Ground Support Equipment
NASA	National Aeronautics and Space Administration
PMZF	Programmable Multi-Zone Furnace
RDR	Requirements Definition Review
SRW	Science Requirements Workshop
SSF	Space Station Freedom
SSFF	Space Station Furnace Facility
TBE	Teledyne Brown Engineering
WBS	Work Breakdown Structure

1.0 INTRODUCTION

This Final Report was prepared by Teledyne Brown Engineering (TBE) in response to Data Requirement Number 8 (DR-8) of the Space Station Furnace Facility (SSFF) Requirements Definition and Conceptual Design Study Contract, NAS8-38077. The report consists of three volumes: Volume I, Executive Summary; Volume II, Technical Report; and Volume III, Program Cost Estimate.

The SSFF Project is divided into two phases: Phase 1, a Definition Study Phase, and Phase 2, a Design and Development Phase. TBE was awarded a research study entitled, "Space Station Furnace Facility Requirements Definition and Conceptual Design Study" on June 2, 1989. This report addresses the Definition Study Phase only. Phase 2 is to be completed after completion of Phase 1. This Phase 1 contractual effort included a basic contract of 12 months' duration with a follow-on option of 18 months. Effective with the award, Arthur S. Kirkindall, of the Marshall Space Flight Center (MSFC), was named Contracting Officer's Technical Representative (COTR) for this contract.

The contract encompassed a requirements definition study and culminated in hardware/facility conceptual designs and hardware demonstration development models to test these conceptual designs. The Study was divided into two parts. Part 1 (the basic part of the effort) encompassed preliminary requirements definition and assessment; conceptual design of the SSFF Core; fabrication of mockups; and preparation for the support of a Conceptual Design Review (CoDR). Part 2 (the optional part of the effort) included detailed definition of the engineering and design requirements, as derived from the science requirements; refinement of the conceptual design of the SSFF Core; fabrication and testing of the "breadboards" or development models; and preparation for and support of a Requirements Definition Review (RDR).

The CoDR was conducted on August 20 and 21, 1990, at MSFC, and Part 1 of the contract was completed on August 31, 1990. Approval for implementation of the contract Option (Part 2) was given on August 31, 1990. The CoDR Board's recommendations included several changes in the tasks planned for Part 2 of the contract. These recommended changes were incorporated into the contract with Modification Number 11, and Authority To Proceed (ATP) was given January 7, 1991. Part 2 culminated in an RDR which was held on May 12 and 13, 1992, at TBE. Part 2 of the contract was completed on May 31, 1992, with the submittal of the Final Study Report.

During this 36-month study effort, the TBE Study Team participated in three major Science Requirements Workshops (SRWs), six Quarterly Reviews, one CoDR, and one RDR.

2.0 COSTING APPROACH, METHODOLOGY and RATIONALE

The approach used to estimate costs for the Space Station Furnace Facility (SSFF) is based on a computer program developed internally at Teledyne Brown Engineering (TBE). The program produces time-phased estimates of cost elements for each hardware component, based on experience with similar components. Engineering estimates of the degree of similarity or difference between the current project and the historical data is then used to adjust the computer-produced cost estimate and to fit it to the current project Work Breakdown Structure (WBS). The SSFF Concept as presented at the Requirements Definition Review (RDR) was used as the base configuration for the cost estimate.

This program incorporates data on costs of previous projects and the allocation of those costs to the components of one of three, time-phased, generic WBSs. Input consists of a list of similar components for which cost data exist, number of interfaces with their type and complexity, identification of the extent to which previous designs are applicable, and programmatic data concerning schedules and miscellaneous data (travel, off-site assignments). Output is program cost in labor hours and material dollars, for each component, broken down by generic WBS task and program schedule phase.

The computer-generated WBS task costs are manually regrouped to match the SSFF WBS. Changes are also made to account for recognized differences between the model component data and the corresponding SSFF components. The results are then transferred to a spreadsheet where labor hours are converted to dollars using a representative labor rate, inflation factors applied, and contingency reserve added to generate the final cost and funding profile.

Figure 2-1 pictorially shows the WBS used for SSFF. Cost estimates are provided for the elements shown in boxes. The next lower level WBS elements are also listed on the figure.

Table 2-1 lists the ground rules and assumptions used in generating cost estimates for SSFF. In particular, we have estimated costs for the two furnace modules generically. We have not attempted to cost a particular furnace design, but rather a generic furnace that is conceptually slightly more challenging than the Crystal Growth Furnace (CGF). The same cost estimate was then used for each furnace, with only the schedule adjusted.

Although the WBS includes both Government and Principal Investigator functions, neither are included in the current cost estimates. These estimates are strictly

contractor costs. Government oversight and management, and PI science-related expenses are not included. However, contractor support to operation of Ground Control Experiment Laboratories (GCELs) for ground based investigations is included.

Costs are categorized as recurring or nonrecurring. The first copy of the SSFF requires all of both categories. Subsequent, build-to-print copies require on the nonrecurring cost. Also, production of specific components of SSFF (such as GCEL, flight unit, training unit, etc.) can be estimated from the tables in section 3 by eliminating the line items specifically identified as associated with units that are not desired.

Integration and operations are considered nonrecurring costs, since only one copy of the SSFF will fly. Continuing costs such as operations and the integration associated with periodic changeout of experiments are explicitly included as nonrecurring. Recurring costs are strictly those costs associated with building additional copies.

Table 2-2 lists the number of each SSFF component used for the total program estimate. These components are based on the program requirements and identified needs for test articles. No explicit inventory of spare parts is identified, although a minimal allowance for spares is included in the component costs.

The milestone schedule used is shown in Figure 2-2. Multiple copies of components, included in the total program funding profiles in section 4, were assumed to be produced concurrently with the initial copy. Subsequent copy costs are, however, self-contained and complete. Subsequent copy schedules can be moved independently.

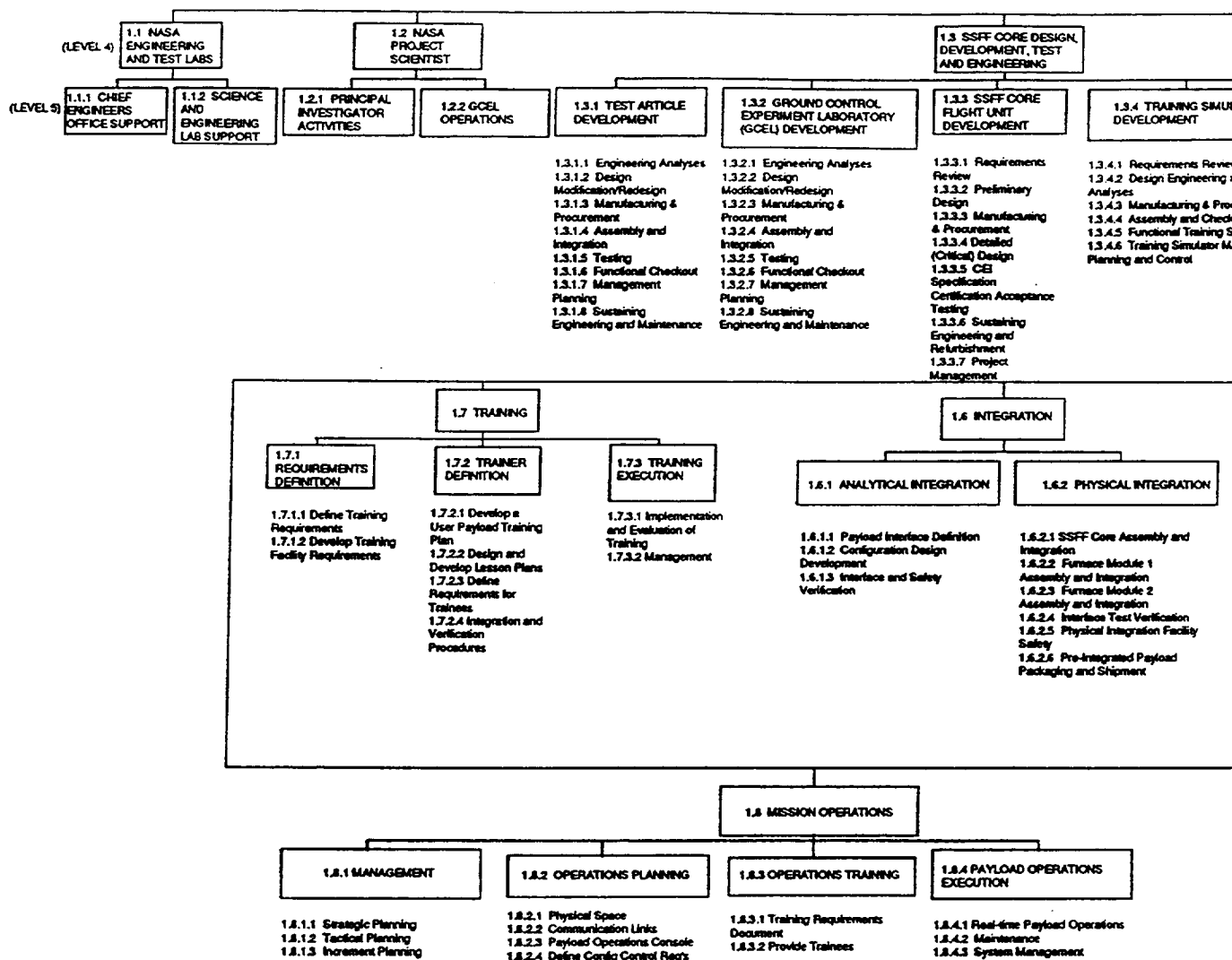
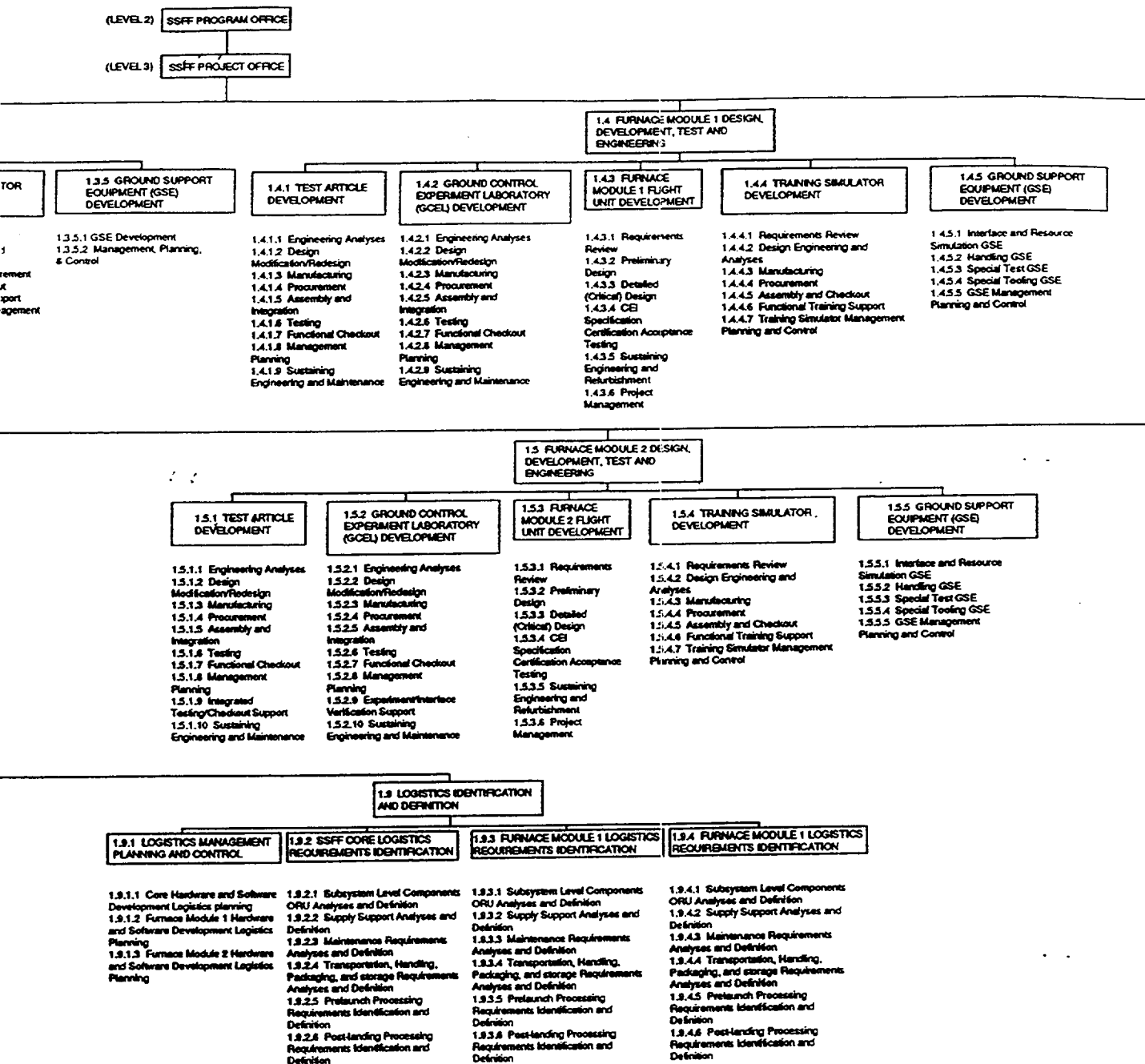


FIGURE 2-1: SPACE STATION FUNCTIONAL WORK BREAKDOWN

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FURNACE FACILITY (SSFF)
STRUCTURE

ORIGINAL PAGE 10
OF POOR QUALITY

FOLDOUT FRAME 2

**FIGURE 2-1. SPACE STATION FURNACE FACILITY WORK BREAKDOWN
STRUCTURE**

TABLE 2-1. GROUND RULES AND ASSUMPTIONS

- Generic Furnace Modules are similar to CGF and Programmable Multi-Zone Furnace (PMZF).
- The SSFF Developer delivers fully integrated racks.
- The quantities specified in Table 2-2 are based on a minimum schedule risk approach to support development, training, ground science, and flight.
- There are no explicit spare parts inventories.
- The full Core hardware simulator is needed at each Furnace Developer.
- Furnace hardware is needed at Core and one Furnace Developer.
- The GCEL is a separate production, not upgraded from Test Article.
- The SSFF Developer provides operating support to GCELS used for ground science.
- For the funding profile, it is assumed that subsequent copies are produced concurrently with the original. Subsequent copy schedules can be moved independently.
- Government management and oversight costs are not estimated.
- Experimenter costs are not estimated.
- Launch costs are not estimated.
- Training development costs are nonrecurring.
- Training execution costs are recurring.

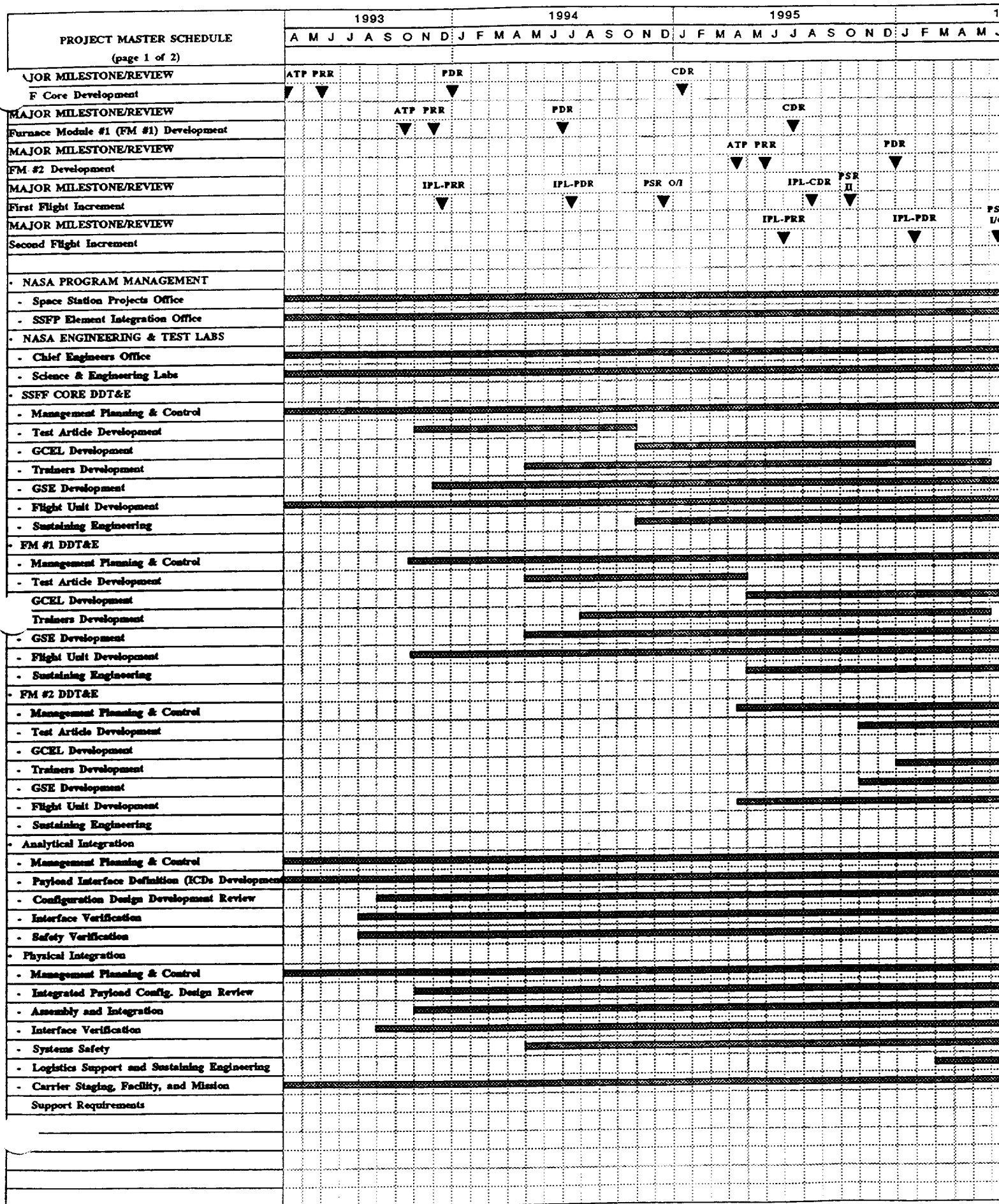
TABLE 2-2. SSFF COMPONENT QUANTITIES

	Hardware	Software	SSF Resource Simulator	Handling GSE	Special Test GSE	Special Tools GSE	Furnace Simulator
Core Test Article	3	3	3	3	1	3	1
GCEL	4*	4*	3**	3**	1**	3**	
Flight Unit	1	1	1	1	1	1	
Furnace Module 1 Test Article	2	2		2	1	2	
GCEL	3	3		2	1	2	
Flight Unit	1	1		1	1	1	
Furnace Module 2 Test Article	2	2		2	1	2	
GCEL	3	3		2	1	2	
Flight Unit	1	1		1	1	1	

* One qualification Test Article, one flight backup

** Upgrade from Test Article

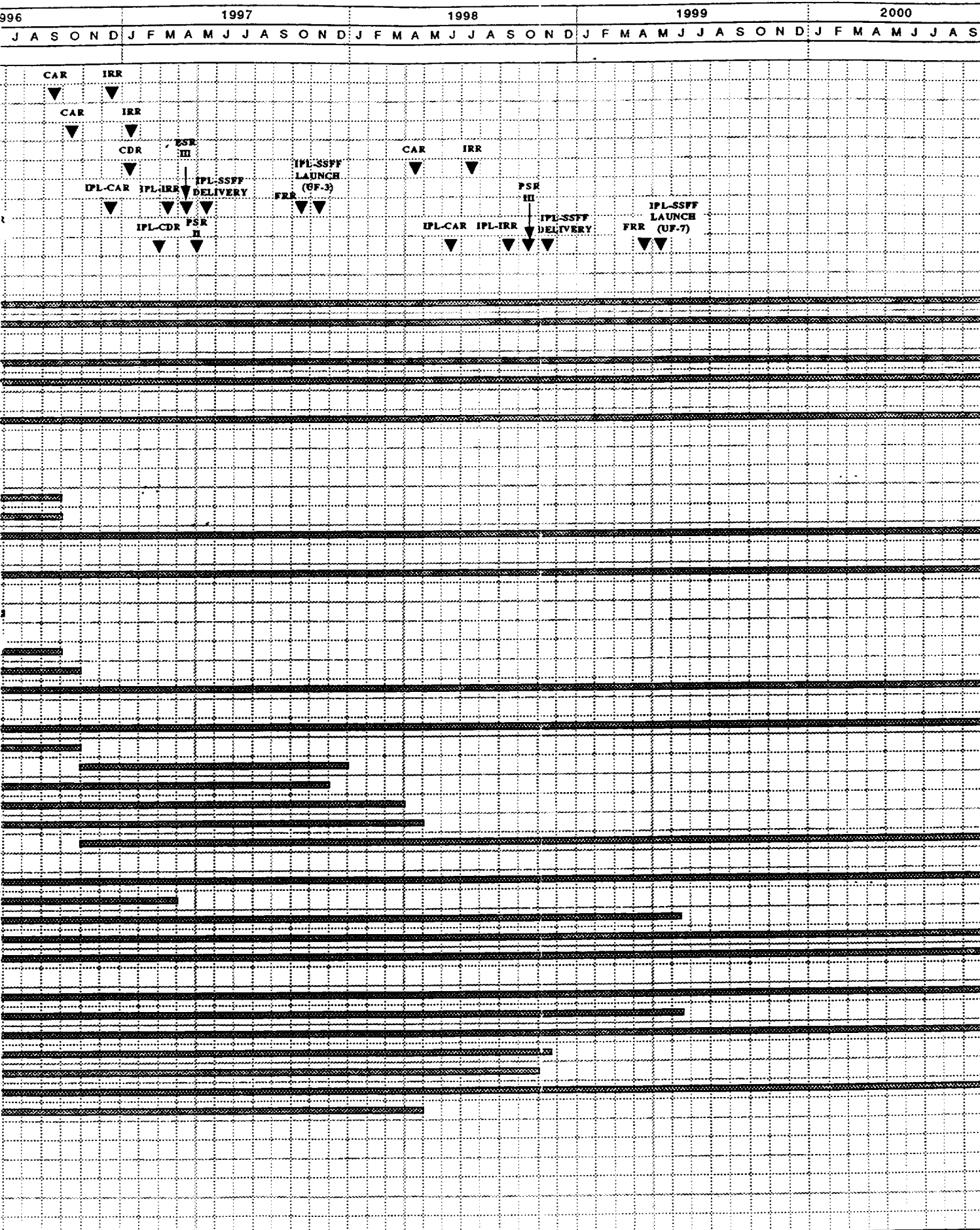
FIGURE 2-2. PROJECT MASTER SCHEDULE (Sheet 1 of 2)

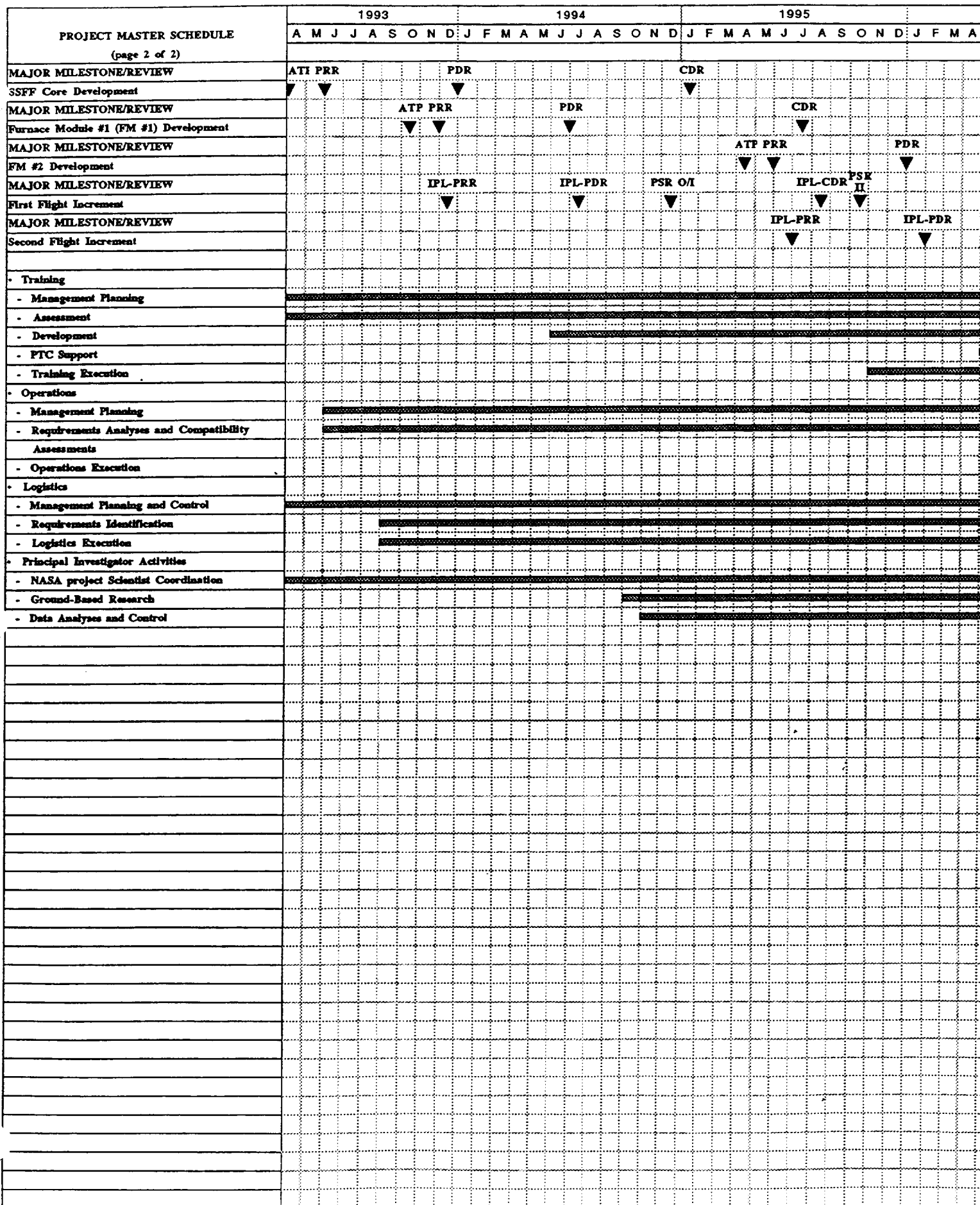


PROJECT MASTER SCHEDULE

FIGURE 2-2: PROJ
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PROJECT MASTER SCHEDULE

FIGURE 2-2: PROJECT
(page 2 of 2)

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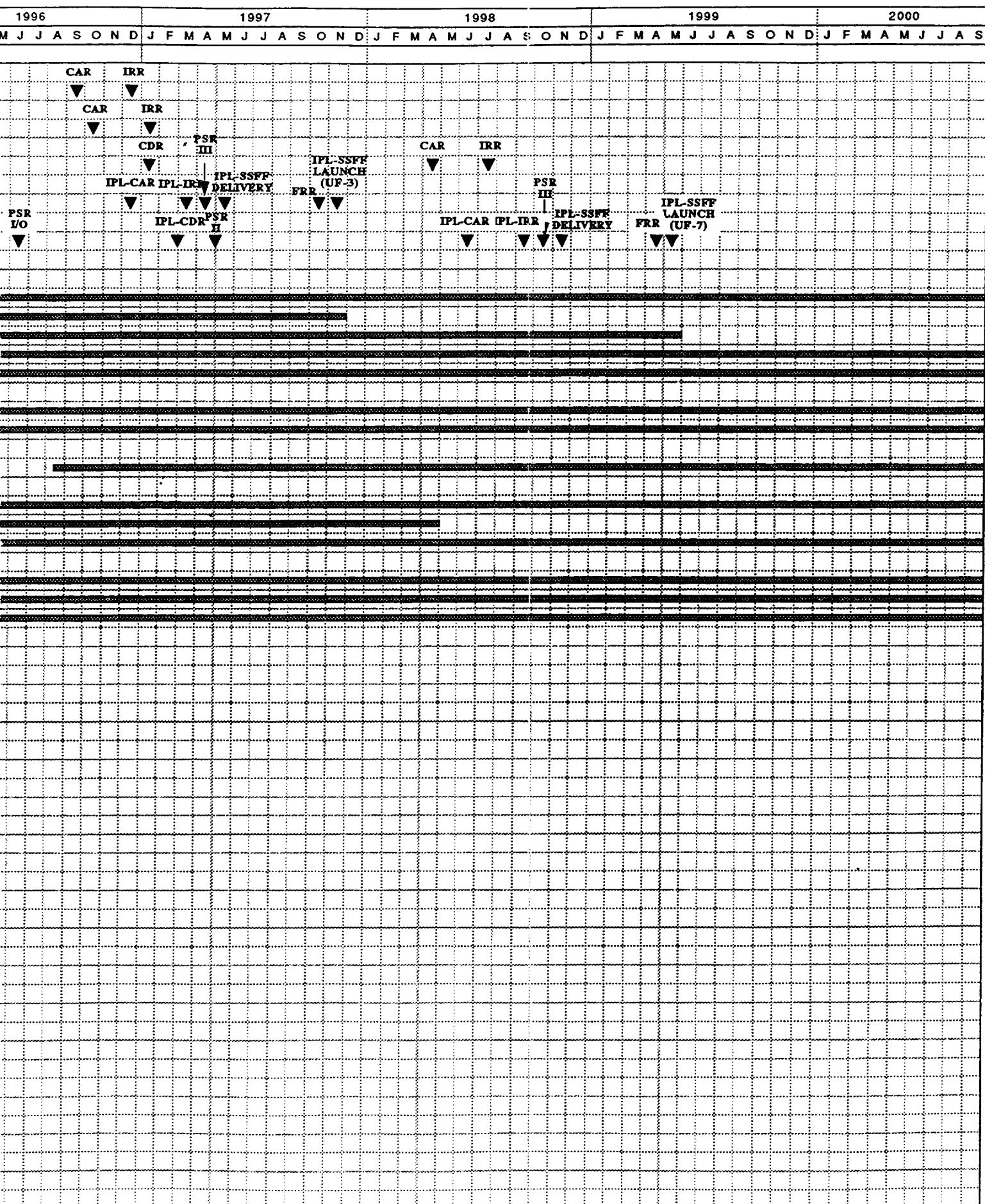


FIGURE 2-2. PROJECT MASTER SCHEDULE (Sheet 2 of 2)

3.0 SUMMARY COST PRESENTATIONS

Table 3-1 summarizes the cost estimates for the initial copy of SSFF by major component and fiscal year in current Government fiscal year dollars. The total program cost, based on the quantities of Table 2-2, is also included. Figure 3-1 graphically illustrates the funding profile for the initial copy of SSFF and the total program.

Contingency allowance is included in the totals, but not in the individual component data.

TABLE 3-1. SSFF SUMMARY COST (Sheet 1 of 2)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
FIRST UNIT SUMMARY										
1.1	NASA ENGINEERING AND TEST LABS	0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST	0	0	0	1425	1503	1585	1665	1748	7927
1.3	SSFF CORE	6877	8831	9281	5035	643	0	0	0	30666
1.4	FURNACE MODULE 1	1308	4587	6463	3027	167	0	0	0	15532
1.5	FURNACE MODULE 2	0	0	1791	6510	7033	1530	199	0	17063
1.6	INTEGRATION	628	1535	2244	1588	1676	271	996	149	9088
1.7	TRAINING	313	1058	2006	3045	2731	1829	1366	1322	13670
1.8	MISSION OPERATIONS	1140	1323	1304	3534	1464	935	996	1046	11741
1.9	LOGISTICS IDENTIFICATION AND DEFINITION	115	232	257	271	145	0	0	0	1019
TOTAL (including inflation) \$K										
	Inflation factor	10381	17545	23345	24435	15381	6150	5222	4265	106706
		1.044	1.098	1.153	1.218	1.285	1.355	1.423	1.494	
CONTINGENCY (30%)										
		3114	5264	7003	7331	4608	1845	1567	1280	32012
INITIAL COPY TOTAL \$K										
		13496	22809	30348	31766	19989	7995	6789	5545	138717

TABLE 3-1. SSFF SUMMARY COST (Sheet 2 of 2)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
TOTAL PROGRAM SUMMARY										
1.1	NASA ENGINEERING AND TEST LABS	.0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST	0	0	0	4275	4510	4756	4995	5244	23780
1.3	SSFF CORE	8054	16252	18053	8141	1324	0	0	0	51823
1.4	FURNACE MODULE 1	2248	8074	12573	4488	167	0	0	0	27551
1.5	FURNACE MODULE 2	0	0	3635	11626	13201	1530	199	0	30191
1.6	MISSION OPERATIONS	1140	1323	1304	3534	1464	935	996	1046	11741
1.7	INTEGRATION	628	1535	2244	1588	1676	271	996	149	9088
1.8	TRAINING	313	1058	2237	4385	4016	2913	2448	2458	19827
1.9	LOGISTICS IDENTIFICATION AND DEFINITION	345	895	770	813	434	0	0	0	3056
TOTAL (including Inflation) \$K										
	Inflation factor	12727	28937	40816	38850	26791	10405	9634	8897	177057
		1.044	1.096	1.153	1.218	1.285	1.355	1.423	1.494	
CONTINGENCY (30%)										
		3818	8681	12245	11655	8037	3122	2890	2669	53117
SSFF PROGRAM TOTAL \$K										
		16545	37618	53061	50505	34828	13527	12524	11566	230174

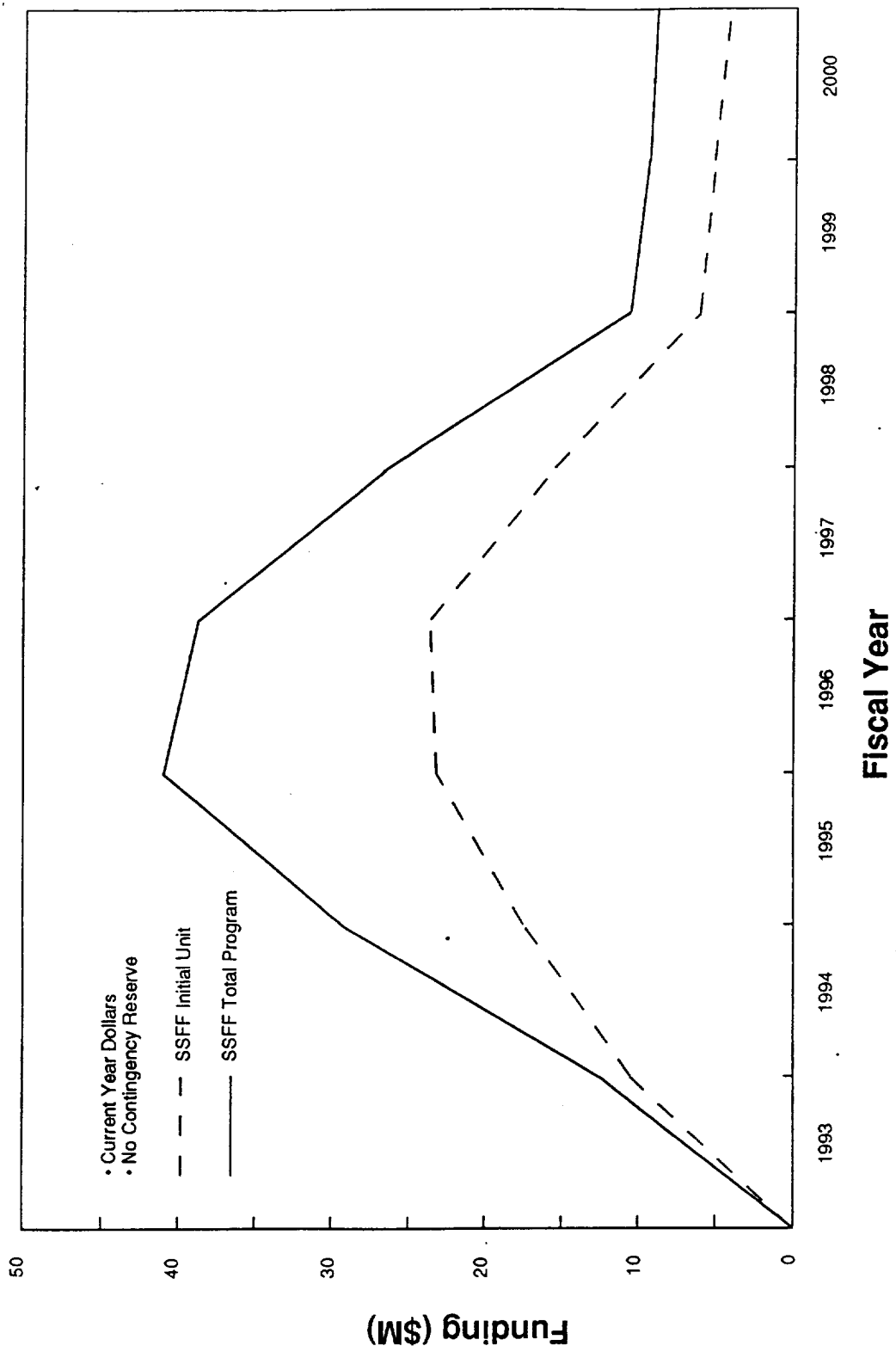


FIGURE 3-1. SSFF FUNDING REQUIREMENT PROFILE

4.0 COST ESTIMATE BY WBS ELEMENT

Tables 4-1 and 4-2 summarize the SSFF cost estimate, for nonrecurring and recurring costs, respectively, by WBS element and year. Separate estimates are shown for labor hours and material dollars, with labor hours converted to equivalent dollars in the bottom line totals. Inflation factors and contingency allowance are also shown.

TABLE 4-1. SPACE STATION FURNACE FACILITY NONRECURRENT COSTS (Sheet 1 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	LABOR (man-years)									(m-yrs)
1.1	NASA ENGINEERING AND TEST LABS	0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST									0
1.2.1	Principle Investigator Activities									0
1.2.2	GCEL Operations	0	0	0	0	0	0	0	0	0
	Sub-total of 1.2									
1.3	SSFF CORE DOT&E									10.85
1.3.1	SSFF Core Test Article Development	8.72	2.13	1.04	0.57					6.39
1.3.2	SSFF Core GCEL Development	0.5	4.28							20.07
1.3.3	SSFF Core Flight Unit Development	9.79	4.99	2.59	2	0.7				7.79
1.3.4	SSFF Core Training Simulator Development	1.06	2.03	2.13	2.07	0.5				16.51
1.3.5	SSFF Core GSE Development	6.14	5.58	2.49	2.3	1.2	0	0	0	61.61
	Sub-total of 1.3	26.21	19.01	8.25	6.94					
1.4	FURNACE MODULE 1 DOT&E									5
1.4.1	Furnace Module 1 Test Article Development	2	2	1						4.4
1.4.2	Furnace Module 1 GCEL Development		2.3	2.1						12.13
1.4.3	Furnace Module 1 Flight Unit Development	2.1	3.35	3.23	2.45	1				6.1
1.4.4	Furnace Module 1 Training Simulator Development		2.4	2.3	1.1	0.3				7.37
1.4.5	Furnace Module 1 GSE Development		3.8	2.12	1.45					35
	Sub-total of 1.4	4.1	13.85	10.75	5	1.3	0	0	0	
1.5	FURNACE MODULE 2 DOT&E									5
1.5.1	Furnace Module 2 Test Article Development			1	3	1				4.4
1.5.2	Furnace Module 2 GCEL Development				3.5	0.9				12.13
1.5.3	Furnace Module 2 Flight Unit Development			1.6	3.58	3.5	2.45	1		6.1
1.5.4	Furnace Module 2 Training Simulator Development				2.1	2.3	1.3	0.4		7.37
1.5.5	Furnace Module 2 GSE Development				2.9	2.93	1.54	1.4	0	35
	Sub-total of 1.5	0	0	2.6	15.08	10.63	5.29			
1.6	INTEGRATION									
1.6.1	Analytical Integration	5.1	6.1	10.45	8.28	1	1	1	1	33.93
1.7.2	Physical Integration	0	5	7	4	12	1	6	35	
	Sub-total of 1.6	5.1	11.1	17.45	12.28	13	2	7	1	68.93

TABLE 4-1. SPACE STATION FURNACE FACILITY NONRECURRENT COSTS (Sheet 2 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
1.7	TRAINING									
1.7.1	Requirements Definition	2.5	1	1.3	0.4	0.3	0.3	0.3	0.3	6.4
1.7.2	Trainer Definition	0.5	7.65	9.1	13.1	10.7	5.7	3.5	2.75	53
1.7.3	Training Execution									0
	Sub-total of 1.7	3	8.65	10.4	13.5	11	6	3.8	3.05	59.4
1.8	MISSION OPERATIONS									
1.8.1	Management	3	3	3	6.5	7	4	1	1	28.5
1.8.2	Operations Planning	1	2.16							3.16
1.8.3	Operations Training	3	3	3	3	3				15
1.8.4	Payload Operations Execution					0.5	2.9	6	6	15.4
	Sub-total of 1.8	7	8.16	6	9.5	10.5	6.9	7	7	62.06
1.9	LOGISTICS IDENTIFICATION AND DEFINITION									
1.9.1	Logistics Management Planning and Control									0
1.9.2	SSFF Core Logistics Requirements Identification									0
1.9.3	Furnace Module 1 Logistics Requirements Identification									0
1.9.4	Furnace Module 2 Logistics Requirements Identification									0
	Sub-total of 1.9	0	0	0	0	0	0	0	0	0
	TOTAL man-years	45.41	60.77	55.45	62.3	47.63	20.19	19.2	11.05	322
	Dollar Equivalent @ \$100k/m-yr (\$k)	4541	6077	5545	6230	4763	2019	1920	1105	32200

TABLE 4-1. SPACE STATION FURNACE FACILITY NONRECURRENT COSTS (Sheet 3 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	MATERIALS (\$K)									(\$K)
1.1	NASA ENGINEERING AND TEST LABS	0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST									
1.2.1	Principle Investigator Activities									
1.2.2	GCEL Operations	0	0	0	0	0	0	0	0	0
	Sub-total of 1.2	0	0	0	0	0	0	0	0	0
1.3	SSFF CORE DOT&E									
1.3.1	SSFF Core Test Article Development	1734.2	738.4	150	232.3	3.5				2622.6
1.3.2	SSFF Core GCEL Development		669	345.7	1196.7	4.5				1250.5
1.3.3	SSFF Core Flight Unit Development	1.5	93.6	1478.7	1196.7	4.5				2775
1.3.4	SSFF Core Training Simulator Development		213.7	492.5	366.9	2				1075.1
1.3.5	SSFF Core GSE Development	1553.4	559.9	151.3						2264.6
	Sub-total of 1.3	3289.1	2274.6	2618.2	1795.9	10	0	0	0	9987.8
1.4	FURNACE MODULE 1 DOT&E									
1.4.1	Furnace Module 1 Test Article Development		175							175
1.4.2	Furnace Module 1 GCEL Development			150	25					175
1.4.3	Furnace Module 1 Flight Unit Development			200	110					310
1.4.4	Furnace Module 1 Training Simulator Development		170	130						300
1.4.5	Furnace Module 1 GSE Development	43	37							80
	Sub-total of 1.4	43	382	480	135	0	0	0	0	1040
1.5	FURNACE MODULE 2 DOT&E									
1.5.1	Furnace Module 2 Test Article Development			50	125					175
1.5.2	Furnace Module 2 GCEL Development				75	100				175
1.5.3	Furnace Module 2 Flight Unit Development				180	130				310
1.5.4	Furnace Module 2 Training Simulator Development				170	130				300
1.5.5	Furnace Module 2 GSE Development			43	37					80
	Sub-total of 1.5	0	0	93	587	360	0	0	0	1040
1.6	INTEGRATION									
1.6.1	Analytical Integration	91.8	90.3	151.4	75.7	4.5				413.7
1.6.2	Physical Integration		200	50						250
	Sub-total of 1.6	91.8	290.3	201.4	75.7	4.5	0	0	0	663.7

TABLE 4-1. SPACE STATION FURNACE FACILITY NONRECURRENT COSTS (Sheet 4 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
1.7	TRAINING									
1.7.1	Requirements Definition									0
1.7.2	Trainer Definition		100	600	600	525	350	200	200	2575
1.7.3	Training Execution									0
	Sub-total of 1.7	0	100	600	600	525	350	200	200	2575
1.8	MISSION OPERATIONS									
1.8.1	Management									0
1.8.2	Operations Planning									0
1.8.3	Operations Training	392	391	531	1951.5	89				3354.5
1.8.4	Payload Operations Execution									0
	Sub-total of 1.8	392	391	531	1951.5	89	0	0	0	3354.5
1.9	LOGISTICS IDENTIFICATION AND DEFINITION									
1.9.1	Logistics Management Planning and Control									0
1.9.2	SSFF Core Logistics Requirements Identification									0
1.9.3	Furnace Module 1 Logistics Requirements Identification									0
1.9.4	Furnace Module 2 Logistics Requirements Identification									0
	Sub-total of 1.9	0	0	0	0	0	0	0	0	0
	TOTAL material dollars	3815.9	3437.9	4523.6	5145.1	988.5	350	200	200	18661

TABLE 4-1. SPACE STATION FURNACE FACILITY NONRECURRENT COSTS (Sheet 5 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	TOTAL (less inflation & contingency) \$k	8356.9	9514.9	10068.6	11375.1	5751.5	2369	2120	1305	50861
	Inflation factor	1.044	1.096	1.153	1.218	1.285	1.355	1.423	1.494	
	TOTAL (including Inflation) \$K	8724.6036	10428.3304	11609.0958	13854.8718	7390.6775	3209.995	3016.76	1949.67	60184.0041
	CONTINGENCY (30%)	2617.38108	3128.49912	3482.72874	4156.46154	2217.20325	962.9985	905.028	584.901	18055.2012
	TOTAL \$K	11341.9847	13556.8295	15091.8245	18011.3333	9607.88075	4172.9935	3921.788	2534.571	78239.2053

TABLE 4-2. SPACE STATION FURNACE FACILITY RECURRING COSTS (Sheet 1 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	LABOR (man-years)									(m-yrs)
1.1	NASA ENGINEERING AND TEST LABS	0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST									
1.2.1	Principal Investigator Activities									
1.2.2	GCEL Operations				6	6	6	6	6	30
	Sub-total of 1.2	0	0	0	6	6	6	6	6	30
1.3	SSFF CORE									
1.3.1	SSFF Core Test Article Development	2	6.1	3.6	0	0	0	0	0	11.7
1.3.2	SSFF Core GCEL Development	0.5	3.77	6.04	0.53	0	0	0	0	10.84
1.3.3	SSFF Core Flight Unit Development	2.27	8.28	9.56	7.38	2.1	0	0	0	29.59
1.3.4	SSFF Core Training Simulator Development	0.5	7.17	6.33	4.05	1.6	0	0	0	19.65
1.3.5	SSFF Core GSE Development	1.5	7.27	4.85	4.48	0	0	0	0	18.1
	Sub-total of 1.3	6.77	32.59	30.38	16.44	3.7	0	0	0	89.88
1.4	FURNACE MODULE 1									
1.4.1	Furnace Module 1 Test Article Development	3	5	1						9
1.4.2	Furnace Module 1 GCEL Development		2	7	1					10
1.4.3	Furnace Module 1 Flight Unit Development	2	3	9	9					23
1.4.4	Furnace Module 1 Training Simulator Development		1	7						8
1.4.5	Furnace Module 1 GSE Development	2	4	4	3					13
	Sub-total of 1.4	7	15	28	13	0	0	0	0	63
1.5	FURNACE MODULE 2									
1.5.1	Furnace Module 2 Test Article Development			1	5	3				9
1.5.2	Furnace Module 2 GCEL Development				5.5	4.5				10
1.5.3	Furnace Module 2 Flight Unit Development			3	4	10	6			23
1.5.4	Furnace Module 2 Training Simulator Development				1	7				8
1.5.5	Furnace Module 2 GSE Development			6	4	3				13
	Sub-total of 1.5	0	0	10	19.5	27.5	6	0	0	63
1.6	INTEGRATION									
1.6.1	Analytical Integration									0
1.6.2	Physical Integration									0
	Sub-total of 1.6	0	0	0	0	0	0	0	0	0

TABLE 4-1. SPACE STATION FURNACE FACILITY RECURRING COST (Sheet 2 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
1.7	TRAINING									
1.7.1	Requirements Definition									0
1.7.2	Trainer Definition									0
1.7.3	Training Execution			1	5.5	5	4	3.8	3.8	23.1
	Sub-total of 1.7	0	0	1	5.5	5	4	3.8	3.8	23.1
1.8	MISSION OPERATIONS									
1.8.1	Management									0
1.8.2	Operations Planning									0
1.8.3	Operations Training									0
1.8.4	Payload Operations Execution									0
	Sub-total of 1.8	0	0	0	0	0	0	0	0	0
1.9	LOGISTICS IDENTIFICATION AND DEFINITION									
1.9.1	Logistics Management Planning and Control	0.1	0.1	0.2	0.2	0.1				0.7
1.9.2	SSFF Core Logistics Requirements Identification	1	2	2	2	1				8
1.9.3	Furnace Module 1 Logistics Requirements Identification		0	0	0					0
1.9.4	Furnace Module 2 Logistics Requirements Identification		0	0	0					0
	Sub-total of 1.9	1.1	2.1	2.2	2.2	1.1	0	0	0	8.7
	TOTAL man-years	14.87	49.69	71.58	62.64	43.3	16	9.8	9.8	277.68
	Dollar Equivalent @ \$100k/m-yr (\$k)	1487	4969	7158	6264	4330	1600	980	980	27768

TABLE 4-1. SPACE STATION FURNACE FACILITY RECURRING COST (Sheet 3 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	MATERIALS (\$K)									(\$K)
1.1	NASA ENGINEERING AND TEST LABS	0	0	0	0	0	0	0	0	0
1.2	NASA PROJECT SCIENTIST									0
1.2.1	Principal Investigator Activities				570	570	570	570	570	2850
1.2.2	GCEL Operations	0	0	0	570	570	570	570	570	2850
	Sub-total of 1.2									
1.3	SSFF CORE									350
1.3.1	SSFF Core Test Article Development		200	150						350
1.3.2	SSFF Core GCEL Development		58	295						353
1.3.3	SSFF Core Flight Unit Development		165	648						813
1.3.4	SSFF Core Training Simulator Development			400						400
1.3.5	SSFF Core GSE Development		200	75						275
	Sub-total of 1.3	0	623	1568	0	0	0	0	0	2191
1.4	FURNACE MODULE 1									500
1.4.1	Furnace Module 1 Test Article Development		500	400	200					600
1.4.2	Furnace Module 1 GCEL Development			450	350					800
1.4.3	Furnace Module 1 Flight Unit Development		300	400						700
1.4.4	Furnace Module 1 Training Simulator Development	100	100							200
1.4.5	Furnace Module 1 GSE Development	100	900	1250	550	0	0	0	0	2800
	Sub-total of 1.4									
1.5	FURNACE MODULE 2									500
1.5.1	Furnace Module 2 Test Article Development			100	400					600
1.5.2	Furnace Module 2 GCEL Development				200	400				800
1.5.3	Furnace Module 2 Flight Unit Development				300	500				700
1.5.4	Furnace Module 2 Training Simulator Development				300	400				200
1.5.5	Furnace Module 2 GSE Development			100	100					200
	Sub-total of 1.5	0	0	200	1300	1300	0	0	0	2800
1.6	INTEGRATION									0
1.6.1	Analytical Integration									0
1.6.2	Physical Integration									0
	Sub-total of 1.6	0	0	0	0	0	0	0	0	0

TABLE 4-1. SPACE STATION FURNACE FACILITY RECURRING COST (Sheet 4 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
1.7	TRAINING									
1.7.1	Requirements Definition									0
1.7.2	Trainer Definition									0
1.7.3	Training Execution									0
	Sub-total of 1.7	0	0	0	0	0	0	0	0	0
1.8	MISSION OPERATIONS									
1.8.1	Management									0
1.8.2	Operations Planning									0
1.8.3	Operations Training									0
1.8.4	Payload Operations Execution									0
	Sub-total of 1.8	0	0	0	0	0	0	0	0	0
1.9	LOGISTICS IDENTIFICATION AND DEFINITION									
1.9.1	Logistics Management Planning and Control									9
1.9.2	SSFF Core Logistics Requirements Identification		1.5	2.5	2.5	2.5				0
1.9.3	Furnace Module 1 Logistics Requirements Identification									0
1.9.4	Furnace Module 2 Logistics Requirements Identification									0
	Sub-total of 1.9	0	1.5	2.5	2.5	2.5	0	0	0	9
	TOTAL material dollars	100	1524.5	3020.5	2422.5	1872.5	570	570	570	10650

TABLE 4-1. SPACE STATION FURNACE FACILITY RECURRING COST (Sheet 5 of 5)

WBS	TITLE	93	94	95	96	97	98	99	0	TOTAL
	TOTAL (less inflation & contingency) \$K	1587	6493.5	10178.5	8686.5	6202.5	2170	1550	1550	38418
	Inflation factor	1.044	1.096	1.153	1.218	1.285	1.355	1.423	1.494	
	TOTAL (including Inflation) \$K	1656.828	7116.876	11735.8105	10580.157	7970.2125	2940.35	2205.65	2315.7	46521.584
	CONTINGENCY (30%)	497.0484	2135.0628	3520.74315	3174.0471	2391.06375	882.105	661.695	694.71	13956.4752
	TOTAL \$K	2153.8764	9251.9388	15256.5537	13754.2041	10361.2763	3822.455	2867.345	3010.41	60478.0592

5.0 TOTAL PROGRAM FUNDING SCHEDULES

Table 5-1 summarizes the total program funding requirements by Government fiscal year program element, based on the quantities given in Table 2-2. Figure 5-1 graphically presents the total program funding profile.

TABLE 5-1. SPACE STATION FURNACE FACILITY TOTAL COST (Sheet 1 of 2)

TITLE	93	94	95	96	97	98	99	0	TOTAL
NON-RECURRING COSTS									
Initial Unit (Flight, Test, GCEI, Training, GSE)									
Labor (man-years)	45	61	55	62	48	20	19	11	322
Materials (\$k)	3816	3438	4524	5145	989	350	200	200	18661
First Copy (Qualification, Test, GCEI, Training, GSE)									
Labor (man-years)									0
Materials (\$k)									0
Second Copy (Backup, Test, Training, GSE)									0
Labor (man-years)									0
Materials (\$k)									0
TOTAL NON-RECURRING COSTS									
Labor (man-years)	45	61	55	62	48	20	19	11	322
Dollar Equivalent @ \$100k/m-yr	4541	6077	5545	6230	4763	2019	1920	1105	32200
Materials (\$k)	3816	3438		5145	989	350	200	200	18661
RECURRING COSTS									
Initial Unit (Flight, Test, GCEI, Training, GSE)									
Labor (man-years)	15			63	43	16	10	10	278
Materials (\$k)	100			2423	1873	570	570	570	10650
First Copy (Qualification, Test, GCEI, Training, GSE)									
Labor (man-years)	13			50	33	10	10	10	232
Materials (\$k)	100			73	1373	570	570	570	9050
Second Copy (Backup, Test, Training, GSE)									
Labor (man-years)	8			37	28	10	10	10	184
Materials (\$k)	100			1323	1373	570	570	570	7187
TOTAL RECURRING COSTS									
Labor (man-years)	35	130	179	150	105	36	29	29	693
Dollar Equivalent @ \$100k/m-yr	3534	12979	17918	14954	10480	3600	2940	2940	69345
Materials (\$k)	300	3909	7414	5518	4618	1710	1710	1710	26887

TABLE 5-1. SPACE STATION FURNACE FACILITY TOTAL COST (Sheet 2 of 2)

TITLE	93	94	95	96	97	98	99	0	TOTAL
TOTAL LABOR (man-years)	81	191	235	212	152	56	49	40	1015
TOTAL LABOR (dollar equivalent @ \$100k/m-yr)	8075	19056	23463	21184	15243	5619	4860	4045	101545
TOTAL MATERIALS (\$K)	4116	7346	11937	10663	5606	2060	1910	1910	45548
TOTAL COST labor + materials (\$K)	12191	26402	35400	31847	20849	7679	6770	5955	147093
Inflation factor	1	1	1	1	1	1	1	1	
TOTAL (including Inflation) \$K	12727	28937	40816	38789	26791	10405	9634	8897	176996
CONTINGENCY (30%)	3818	8681	12245	11637	8037	3122	2890	2669	53099
TOTAL \$K	16545	37618	53061	50426	34828	13527	12524	11566	230095

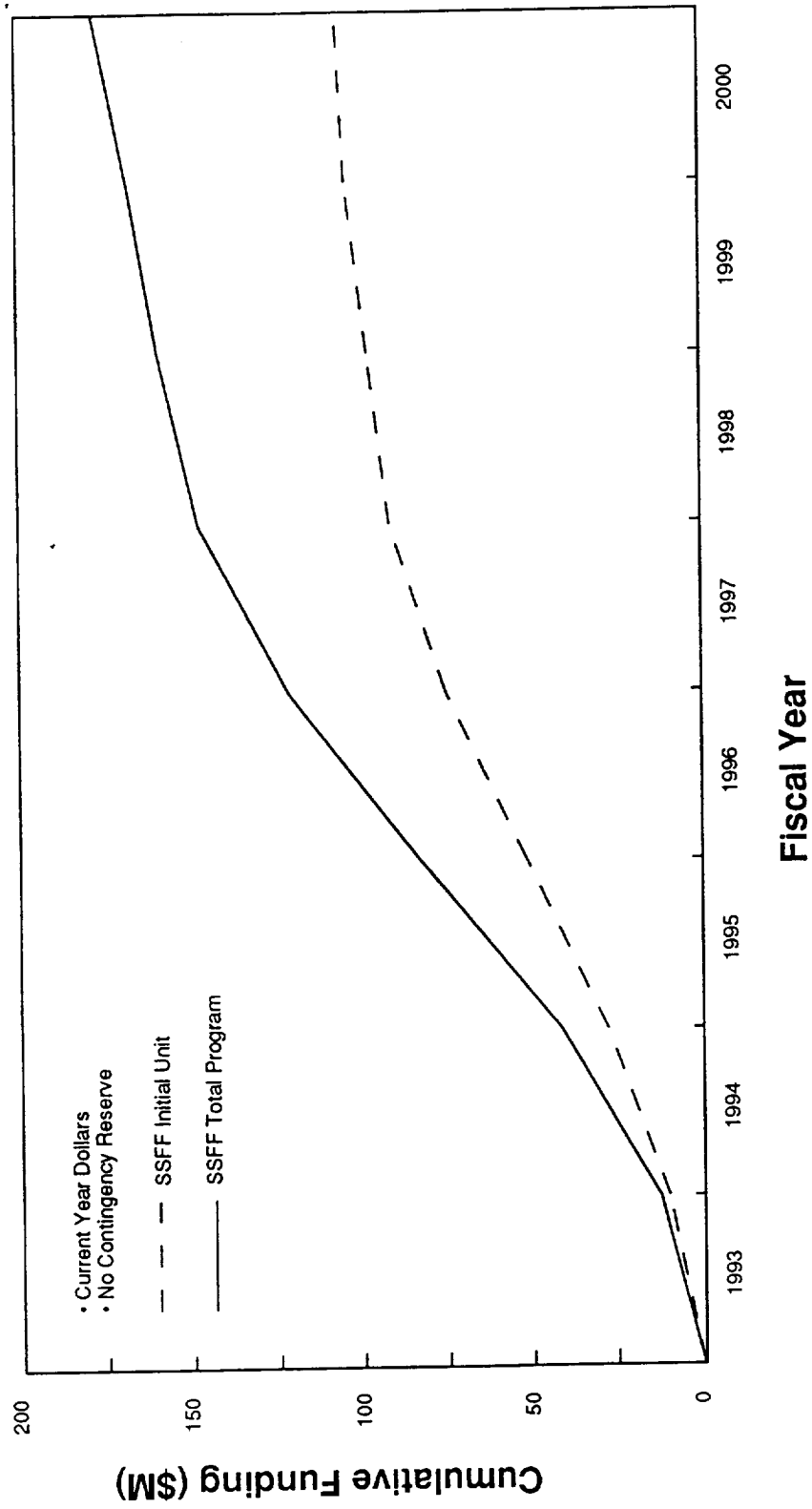


FIGURE 5-1. SSFF CUMULATIVE FUNDING REQUIREMENT PROFILE

APPENDIX A

WBS DICTIONARY



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

3

WBS LEVEL

1.0

WBS NUMBER

SSFF Project

WBS TITLE

DEFINITION

Effort to define, develop, and implement a Space Station Furnace Facility on the Space Station Freedom.

WORK CONTENT

SOW PAR

Project includes the following elements:

NASA Engineering Support
NASA Project Scientist Support
SSFF Core Development
Furnace Module 1 Development
Furnace Module 2 Development
Integration
Training
Mission Operations
Logistics



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MISSION

4

WBS LEVEL

1.1

WBS NUMBER

NASA Engineering

WBS TITLE

DEFINITION

Engineering support to develop, review, analyze, verify, and approve hardware specifications, test data, analyses data, procedures, and other technical data relating to the SSFF Project.

WORK CONTENT

SOW PAR



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SSFF

MISSION

4

WBS LEVEL

1.2

WBS NUMBER

NASA Project Scientist

WBS TITLE

DEFINITION

Performing the activities required to coordinate ground-based research and documentation of science requirements. Also includes performing the Principal Investigators research and operating GCEL equipment for preflight sample preparation and control experiments.

WORK CONTENT

SOW PAR

Principal Investigator Activities GCEL Operations



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.2.1

WBS NUMBER

Principal Investigator Activities

WBS TITLE

DEFINITION

Performing science research forming the basis for the Flight experiments.

WORK CONTENT

SOW PAR

Activities are research specific.



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SSFF

MISSION

5

WBS LEVEL

1.2.2

WBS NUMBER

GCEL Operations

WBS TITLE

DEFINITION

Operating the SSFF GCEL to prepare samples for flight and conduct parallel ground based experiments as controls for post-flight analysis. SSFF GCEL includes a GCEL of the Core and each Furance Module.

WORK CONTENT

SOW PAR

Activities include:

- Plan the operation runs.
- Configure GCEL Systems for runs.
- Staff the runs with appropriate operators.
- Perform post-run shutdown and inspection.



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MISSION

4

WBS LEVEL

1.3.0.0

WBS NUMBER

SSFF Core Design, Development, Test and Engineering

WBS TITLE

DEFINITION

The Design, Development, Test, and Engineering (DDT&E) element will include the activities required to design, manufacture, procure, verify and test the SSFF hardware and software and provide continuing support for Integration and Operations.

WORK CONTENT

SOW PAR

Activities incorporated into this element include:

- Design requirements review
- Interface definition review and support
- Concept identification
- Concept trade studies and selection
- SSFF design
- Ground Support Equipment (GSE) identification and design
- Test equipment identification and design
- Training equipment design
- Design support documentation preparation
- Support facilities requirements identification
- Manufacturing activities and support
- Procurement activities and support
- Testing activities and support
- Analytical integration support
- Physical integration support
- Flight and mission operations support
- Verification activities
- Review support

Deliverables:

GSE Test Sets
3 Test Articles
4 Ground Control Experiment Laboratory (GCEL) Units
Flight Unit.
3 Training Simulators



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5

WBS LEVEL

1.3.1

WBS NUMBER

Test Article Development

WBS TITLE

DEFINITION

The development of the Test Article hardware and software is required to demonstrate the technological design approach for the SSFF Core Flight Unit, including interface compatibility and equipment functionality.

WORK CONTENT

SOW PAR

Activities include:

- Systems Engineering Analyses of SSFF Core Engineering Design
- Modification/redesign of Core Flight Designs for DTA designs
- Fabrication and/or procurement of SSFF DTA components
- Assembly and Integration of the DTA components and systems
- Testing of the DTA components and Integrated DTA system
- Functional checkout of DTA system
- Management

Deliverable:

3 Test Articles
GSE Sets



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MISSION

6

WBS LEVEL

1.3.1.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analyses activities to the review of components identified as part of the preliminary design input for the PDR, and determine appropriate modifications for application to DTA.

WORK CONTENT

SOW PAR

Engineering Analyses include:

- Defining of Operating requirements and environment for each component
- Review function of each component
- Researching the capabilities of off-the-shelf equipment
- Select substitute commercial components
- Generation of functional block diagrams and schematics
- Performing cursory analyses of Test Article component configuration
- Identify components requiring redesign



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MISSION

6

WBS LEVEL

1.3.1.02

WBS NUMBER

Design Modification/Redesign

WBS TITLE

DEFINITION

The actual design modification or redesign analyses of the Flight Unit design input and the generation of drawings to support the development of components required to make the Test Article.

WORK CONTENT

SOW PAR

Design activities include:

- Review of requirements for component function
- Generation of component design drawings
- Development of support structure drawings
- Modification of existing design drawings
- Generation of assembly and integration drawings



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MISSION

6

WBS LEVEL

1.3.1.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

The review of drawings developed through the design modification or redesign activities, development of fabrication plans including the identification of quality inspection points, and the actual fabrication of the components for the DTA. The manufacturing activities will begin after the PDR and after receiving approval from NASA.

WORK CONTENT

SOW PAR

Activities include:

- Requisition of off-the-shelf equipment
- Evaluation of the required components for functionality and physical interface agreement
- Interfacing with the designers in the event that the commercial component identified is not available
- Red line/modify design drawings
- Procure raw materials
- Develop Fabrication plans
- Develop quality inspect procedures
- Fabricate each part



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SSFF

MISSION

6

WBS LEVEL

1.3.1.04

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Test Article and supporting equipment, and the integration of all Test Article subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Test Article subsystems
- Integration of the Test Article with appropriate test set equipment



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MISSION

6

WBS LEVEL

1.3.1.05

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Performance confirmation testing and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the Test Article assembly. The identification of appropriate facilities, whether in-house or subcontractor facilities, to conduct the testing activities will be required. These testing activities will require the use of GSE test sets, which will be designed and developed in parallel with the Test Article components, and will take into account the Test Article use environment and available resources.

WORK CONTENT

SOW PAR

Testing activities include:

- Verification of fabricated and procured items
- Testing to verify component operation within designed or advertised specifications in their intended use environments
- Testing of subsystem for intended use environments



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MISSION

6

WBS LEVEL

1.3.1.06

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the Test Article system equipment for evaluation of the functional performance of all components planned for use in the Flight Unit design, and the identification of design improvements.

WORK CONTENT

SOW PAR

Functional Checkout includes:

- Operation and monitoring of all subsystems
- Acquiring functional performance data of DTA systems and components
- Data reduction and analysis



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SSFF

MISSION

1

WBS LEVEL

1.3.1.07

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Test Article development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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SSFF

MISSION

6

WBS LEVEL

1.3.1.08

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during DTA operation and testing.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of DTA performance
- Support the reconfiguring of the DTA for PI testing



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2

WBS NUMBER

Ground Control Experiment Laboratory (GCEL) Development

WBS TITLE

DEFINITION

The development of the SSFF Core Ground Control Experiment Laboratory (GCEL) hardware and software is required for qualification activities, to provide SSFF Core capabilities and flight identical interfaces as simulation. GSE for FM GCEL hardware and software, to perform parallel ground operation of the on-orbit Flight Unit hardware and software, and to perform interface verification of Core ORUs and incremental FM hardware and software that will interface with the SSFF Core on-orbit, in particular the FM 2 hardware and software. The development of the SSFF Core GCEL will also allow ground-based assessment of on-orbit activities prior to and during the SSFF term on-orbit, as well as provide a means for verifying both physically and functionally any ORUs or incremental hardware and software that will interface with SSFF Core centralized and/or distributed equipment.

WORK CONTENT

SOW PAR

Activities include:

- Engineering analyses
- Manufacturing
- Procurement
- Assembly and integration
- Component and assembly testing
- Management planning
- Functional checkout activities
- Sustaining Engineering and Operations Support

Deliverables

- Four GCELs



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analysis consists of the activities required to review the SSFF Core CDR design drawings and determine requirements for GCEL development and testing.

WORK CONTENT

SOW PAR

Engineering analyses activities will include:

- Review of components identified as the critical design input
- Review of the function of each of these components in their intended use environment
- Identification of component physical qualification testing
- Providing analyses to the development of qualification test plans.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the GCEL after a review of the engineering design.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving, inspecting, and inventorying materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Core GCEL and supporting equipment, and the integration of all Core GCEL subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the GCEL subsystems
- Integration of the GCEL assembly with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the GCEL assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Core Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities.
- Test components within designed or advertised specifications.
- Evaluate component and system performance for GCEL application.
- Perform qualification testing on GCEL for flight environment.
- Compile test data for verification of interfaces.



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SSFF

MISSION

6

WBS LEVEL

1.3.2.07

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the GCEL to simulate flight operations to evaluate system performance of the flight design.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Operation of the GCEL system equipment
- Evaluation of the GCEL performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



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BROWN ENGINEERING**

WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.2.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the SSFF Core GCEL development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

The schedule preparation activities involve:

- Reviewing the GCEL development activities requirements
- Preparing schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
- Developing facilities usage schedules



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.2.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during Integration and Operations.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Flight Unit performance
- Support to GCEL operations during sample preparation and ground control experimentation.



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.3.3

WBS NUMBER

SSFF Core Flight Unit

WBS TITLE

DEFINITION

Development of the Flight hardware and support of the integration and delivery of the SSFF Core.

WORK CONTENT

SOW PAR

Activities include:

- Review of Requirements
- Development of Preliminary Design Input for DTA
- Development of Critical Design Input for GCEL
- Manufacture and procure flight hardware
- Testing for acceptance and verification
- Sustaining Engineering through integration and operations
- Management planning

Deliverables:

1 Flight Unit
Spares



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Effort to begin the detailed analyses of the chosen subsystems, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, FM developers, and the science community planning to use the SSFF (i.e., the Principal Investigators (PIs)).

WORK CONTENT

SOW PAR

Activities include:

- Reviewing inputs from schematics and documentation
- Developing functional interface block diagrams and schematics
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.3.02

WBS NUMBER

Preliminary Design

WBS TITLE

DEFINITION

The Preliminary Design activity initiates the development of parts drawings, assembly drawings, and the subsequent design analyses documentation of the selected Core design concept.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated will include the following deliverables for the PDR as a minimum:

- Preliminary Engineering Analyses
- Analytical Integration Documentation Support
- Facilities Requirements Identification
- Ground Support Equipment (GSE) Requirements Identification
- Phase O/I Safety Analyses and Documentation
- Preliminary Design Review Support
- Phased Safety Documentation for Formal Safety Review
- Software Requirements Document
- Verification Planning Documentation



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.03

WBS NUMBER

Critical Design

WBS TITLE

DEFINITION

The Critical Design Analyses and Documentation Preparation for the SSFF Core is the effort to finalize the detailed analyses of the chosen design approach, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, FM developers, and the PIs at the CDR. These design inputs will either be updates to documentation submitted at the PDR, or new inputs.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated will include the following deliverables for the CDR as a minimum:

- Baseline Issue Parts Drawings
- Baseline Issue Assembly and Integration Drawings
- Latest Quarterly Update of Mass Properties Report
- Final Materials Identification and Usage List
- Updated Power Profiles
- Baseline Issue Command and Data Management Schematics
- Baseline Issue Electrical Power Interface Schematics
- Updated Structural Analyses Report
- Phase II Safety Packages
- Updated Software Requirements Document
- Baseline Issue Verification Plan
- Detailed Engineering Analyses
- Design Engineering and Analyses (Updates)
- Analytical Integration Documentation Support
- Phase II Safety Analyses and Documentation
- Detailed (Critical) Design Review Support
- Manufacturing
- Procurement
- Phase II Safety Review Support
- Assembly and Integration Support
- Interface Verification Support
 - Analytical
 - Testing



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.3.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the flight unit from a review of the engineering design.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Flight Unit and supporting equipment, and the integration of all Flight Unit subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the Core subsystems
- Integration of the Core assembly with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the Flight Unit assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Core Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities
- Test components within designed or advertised specifications
- Evaluate component and system performance Flight Unit
- Perform appropriate qualification testing for the flight environment.
- Compile test data for verification of interfaces.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.07

WBS NUMBER

Acceptance Testing and Functional Verification

WBS TITLE

DEFINITION

Testing of GCEL and Flight Unit to verify the performance in accordance with the CEI Specification.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Evaluation of the Flight Unit performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.3.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the SSFF Core development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

- The schedule preparation activities involve:
- Reviewing the development activities requirements
 - Preparing schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
 - Developing facilities usage schedules



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.3.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during Integration and Operations.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alterante component design
- Design of modifications to components for repair or enhancement of Flight Unit performance
- Support to Mission Integration and Operations



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.3.4

WBS NUMBER

Training Simulator Development

WBS TITLE

DEFINITION

Effort to design and develop the Training simulators defined in WBS 1.7.2

WORK CONTENT

SOW PAR

Activities include:

- Review of requirements for trainers
- Engineering Analyses and Design of trainers
- Manufacture and Procurement of trainer components
- Assembly, Integration, and checkout of trainers
- Training support for repair and maintenance
- Management Planning and Control



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Review of training requirements in PTRD.

WORK CONTENT

SOW PAR

- Reviewing inputs from schematics and documentation
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.02

WBS NUMBER

Design Engineering and Analyses

WBS TITLE

DEFINITION

Design selection and systems engineering analysis of components for the development of Trainer Simulators

WORK CONTENT

SOW PAR

Activities include:

- Identification of commercial equipment providing function or crew interface of flight component
- Evaluation/ Assessment of fidelity of commercial equipment
- Development of design drawings for alternate components or modifications to components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the Trainers.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.04

WBS NUMBER

Assembly and Checkout

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Trainers and supporting equipment, and the integration of all subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Assemble parts into components

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Trainers subsystems
- Integration of the Trainers with appropriate test set equipment
- Testing of units to verify compliance with requirements



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.06

WBS NUMBER

Functional Training Support

WBS TITLE

DEFINITION

Maintaining support for operation, repair, refurbishment or upgrade of trainers for mission specific training.

WORK CONTENT

SOW PAR

Activities Include:

- Identification of Mission Specific training Requirements
- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Trainer performance



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.3.4.07

WBS NUMBER

Training Simulator Management Planning and Control

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Trainers development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.3.5.0

WBS NUMBER

Ground Support Equipment

WBS TITLE

DEFINITION

Effort required to develop and control the utilization of GSE during the SSFF Core Development

WORK CONTENT

SOW PAR

Development of SSFF Core GSE.
Scheduling and Management Planning of GSE.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.3.5.1

WBS NUMBER

Ground Support Equipment (GSE) Development

WBS TITLE

DEFINITION

This Effort develops or procures GSE required to support testing, assembly integration, and checkout operations for the Flight, DTA, and GCEL activities.

WORK CONTENT

SOW PAR

Activities include:

- Development of Interface and Resource Simulators
- Handling GSE
- Special Test GSE
- Special Tooling GSE
- Management



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.3.5.2

WBS NUMBER

GSE Management Planning and Control

WBS TITLE

DEFINITION

Effort to plan the utilization and scheduling of GSE between the separate development efforts on the SSFF Core.

WORK CONTENT

SOW PAR

Development of utilization schedules
Logistical Analysis
Development of Maintenance plan
Development of operation manuals
Logging and tracking GSE usage.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

4

WBS LEVEL

1.4.0.0

WBS NUMBER

Furnace Module 1 Design, Development, Test and Engineering

WBS TITLE

DEFINITION

The Design, Development, Test, and Engineering (DDT&E) element will include the activities required to design, manufacture, procure, verify and test the SSFF hardware and software and provide continuing support for Integration and Operations.

WORK CONTENT

SOW PAR

Activities incorporated into this element include:

- Design requirements review
- Interface definition review and support
- Concept identification
- Concept trade studies and selection
- SSFF design
- Ground Support Equipment (GSE) identification and design
- Test equipment identification and design
- Training equipment design
- Design support documentation preparation
- Support facilities requirements identification
- Manufacturing activities and support
- Procurement activities and support
- Testing activities and support
- Analytical integration support
- Physical integration support
- Flight and mission operations support
- Verification activities
- Review support

Deliverables:

GSE Test Sets
2 Test Articles
3 Ground Control Experiment Laboratory (GCEL) Units
Flight Unit.
3 Training Simulators



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.4.1

WBS NUMBER

Test Article Development

WBS TITLE

DEFINITION

The development of the Test Article hardware and software is required to demonstrate the technological design approach for the Furnace Module 1 Flight Unit, including interface compatibility and equipment functionality.

WORK CONTENT

SOW PAR

Activities Include:

- Systems Engineering Analyses of Furnace Module 1 Engineering Design
- Modification/redesign of Furnace Flight designs for DTA application
- Fabrication and Assembly and/or Procurement of SSFF DTA Components.
- Assembly and Integration of the DTA components and systems
- Testing of the DTA components and Integrated DTA system.
- Functional Checkout of DTA system
- Management

Deliverable:

2 Test Articles
GSE Sets



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analyses activities to the review of components identified as part of the preliminary design input for the PDR, and determine appropriate modifications for application to DTA.

WORK CONTENT

SOW PAR

Engineering Analyses include:

- Definition of Operating requirements and environment for each component.
- Review function of each component
- Researching the capabilities of off-the-shelf equipment
- Select substitute commercial components
- Generation of functional block diagrams and schematics
- Performing cursory analyses of Test Article component configuration
- Identify components requiring redesign



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.02

WBS NUMBER

Design Modification/Redesign

WBS TITLE

DEFINITION

The actual design modification or redesign analyses of the Flight Unit design input and the generation of drawings to support the development of components required to make the Test Article.

WORK CONTENT

SOW PAR

Design activities include:

- Review of requirements for component function
- Generation of component design drawings
- Development of support structure drawings
- Modification of existing design drawings
- Generation of assembly and integration drawings



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

The review of drawings developed through the design modification or redesign activities, development of fabrication plans including the identification of quality inspection points, and the actual fabrication of the components for the DTA. The manufacturing activities will begin after the PDR and after receiving approval from NASA.

WORK CONTENT

SOW PAR

Activites include:

- Requisition of off-the-shelf equipment
- Evaluation of the required components for functionality and physical interface agreement
- Interfacing with the designers in the event that the commercial component identified is not available
- Red line/modify design drawings
- Procure raw materials
- Develop Fabrication plans
- Develop quality inspect procedures.
- Fabricate each part



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.04

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Test Article and supporting equipment, and the integration of all Test Article subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Test Article subsystems
- Integration of the Test Article with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.05

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Performance confirmation testing and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the Test Article assembly. The identification of appropriate facilities, whether in-house or subcontractor facilities, to conduct the testing activities will be required. These testing activities will require the use of GSE test sets, which will be designed and developed in parallel with the Test Article components, and will take into account the Test Article use environment and available resources.

WORK CONTENT

SOW PAR

Testing activities include:

- Verification of fabricated and procured items
- Testing to verify component operation within designed or advertised specifications in their intended use environments
- Testing of subsystem for intended use environments



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.06

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the Test Article system equipment for evaluation of the functional performance of all components planned for use in the Flight Unit design, and the identification of design improvements.

WORK CONTENT

SOW PAR

Functional Checkout includes:

- Operation and monitoring of all subsystems
- Acquiring functional performance data of DTA systems and components
- Data reduction and analysis



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.1.07

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Test Article development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.1.08

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during DTA operation and testing.

WORK CONTENT

SOW PAR

Activities Include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of DTA performance
- Support the configuring of the DTA for PI experiments



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2

WBS NUMBER

Ground Control Experiment Laboratory (GCEL) Development

WBS TITLE

DEFINITION

The development of the Furnace Module 1 Ground Control Experiment Laboratory (GCEL) hardware and software is required for qualification activities, to provide Furnace Module 1 capabilities and flight identical interfaces as simulation GSE for Core GCEL hardware and software, and to perform parallel ground operation of the on-orbit Flight Unit hardware and software.

WORK CONTENT

SOW PAR

Activities include:

- Engineering analyses
- Manufacturing
- Procurement
- Assembly and integration
- Component and assembly testing
- Management planning
- Functional checkout activities
- Sustaining Engineering

Deliverables

- 3 GCELs



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analysis consists of the activities required to review the Furnace Module 1 CDR design drawings and determine requirements for GCEL development and testing.

WORK CONTENT

SOW PAR

Engineering analyses activities will include:

- Review of components identified as the critical design input
- Review of the function of each of these components in their intended use environment
- Identification of component physical qualification testing
- Providing analyses to the development of qualification test plans.



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the GCEL after a review of the engineering design from the CDR.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Furnace GCEL and supporting equipment, and the integration of all Furnace GCEL subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble parts into components
- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the GCEL subsystems
- Integration of the GCEL assembly with appropriate test set equipment



**TELEDYNE
BROWN ENGINEERING**

WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the GCEL assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Furnace Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities
- Test components within designed or advertised specifications
- Evaluate component and system performance for GCEL application.
- Perform qualification testing on GCEL for flight environment.
- Compile test data for verification of interfaces.



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.07

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the GCEL to simulate flight operations to evaluate system performance of the flight design.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Operation of the GCEL system equipment
- Evaluation of the GCEL performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



**TELEDYNE
BROWN ENGINEERING**

WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.2.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the Furnace Module 1 GCEL development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

The schedule preparation activities involve:

- Reviewing the GCEL development activities requirements
- Schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
- Developing facilities usage schedules



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.2.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during GCEL operation and testing.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of GCEL performance
- Support to GCEL operations during PI ground control experiment operation



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.4.3

WBS NUMBER

Furnace Module 1 Flight Unit

WBS TITLE

DEFINITION

Development of the Flight hardware and support of the integration and delivery of the Furnace Module 1.

WORK CONTENT

SOW PAR

Activities include:

- Review of Requirements
- Development of Preliminary Design Input for DTA
- Development of Critical Design Input for GCEL
- Manufacture and Procure of flight hardware
- Testing for acceptance and verification
- Sustaining Engineering through integration and operations
- Management planning

Deliverables:

1 Flight Unit
Spares



**TELEDYNE
BROWN ENGINEERING**

WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Effort to begin the detailed analyses of the chosen subsystems, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, FM developers, and the science community planning to use the SSFF (i.e., the Principal Investigators (PIs)).

WORK CONTENT

SOW PAR

Activities include:

- Reviewing inputs from schematics and documentation
- Developing functional interface block diagrams and schematics
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.3.02

WBS NUMBER

Preliminary Design

WBS TITLE

DEFINITION

The Preliminary Design activity initiates the development of parts drawings, assembly drawings, and the subsequent design analyses documentation of the selected furnace concept.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated per the IROP document will include the following deliverables for the PDR as a minimum:

- Preliminary Engineering Analyses
- Analytical Integration Documentation Support
- Facilities Requirements Identification
- Ground Support Equipment (GSE) Requirements Identification
- Phase O/I Safety Analyses and Documentation
- Preliminary Design Review Support
- Phased Safety Documentation for Formal Safety Review
- Software Requirements Document
- Verification Planning Documentation



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.03

WBS NUMBER

Critical Design

WBS TITLE

DEFINITION

The Critical Design Analyses and Documentation Preparation for the Furnace Module 1 is the effort to finalize the detailed analyses of the chosen design approach, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, Core Developer, and the PIs at the CDR. These design inputs will either be updates to documentation submitted at the PDR, or new inputs.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated per the IROP document will include the following deliverables for the CDR as a minimum:

- Baseline Issue Parts Drawings
- Baseline Issue Assembly and Integration Drawings
- Latest Quarterly Update of Mass Properties Report
- Final Materials Identification and Usage List
- Updated Power Profiles
- Baseline Issue Command and Data Management Schematics
- Baseline Issue Electrical Power Interface Schematics
- Updated Structural Analyses Report
- Phase II Safety Packages
- Updated Software Requirements Document
- Baseline Issue Verification Plan
- Detailed Engineering Analyses
- Design Engineering and Analyses (Updates)
- Analytical Integration Documentation Support
- Phase II Safety Analyses and Documentation
- Detailed (Critical) Design Review Support
- Manufacturing
- Procurement
- Phase II Safety Review Support
- Assembly and Integration Support
- Interface Verification Support
 - Analytical
 - Testing



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.3.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the Flight Unit from a review of the engineering design.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Furnace Flight Unit and supporting equipment, and the integration of all Furnace Flight Unit subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the Furnace subsystems
- Integration of the Furnace assembly with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the Flight Unit assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities
- Test components within designed or advertised specifications
- Evaluate component and system performance
- Perform qualification testing for the flight environment.
- Compile test data for verification of interfaces.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.07

WBS NUMBER

Acceptance Testing and Functional Checkout

WBS TITLE

DEFINITION

Testing of GCEL and Flight Unit to verify performance in accordance with the CEI Specification.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Evaluation of the Flight Unit performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.3.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the Furnace Module development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

- The schedule preparation activities involve:
- Reviewing the development activities requirements
 - Preparing schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
 - Developing facilities usage schedules



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.3.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during Integration and Operations.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Flight Unit performance
- Support to mission Integration and Operations.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.4.4

WBS NUMBER

Training Simulator Development

WBS TITLE

DEFINITION

Effort to design and develop the Training simulators defined in WBS 1.7.2

WORK CONTENT

SOW PAR

Activities include:

- Review of requirements for trainers
- Engineering Analyses and Design of trainers
- Manufacture and Procurement of trainer components
- Assembly, Integration, and checkout of trainers
- Training support for repair and maintenance
- Management Planning and Control



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Review of training requirements in PTRD.

WORK CONTENT

SOW PAR

- Reviewing inputs from schematics and documentation
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.02

WBS NUMBER

Design Engineering and Analyses

WBS TITLE

DEFINITION

Design selection and systems engineering analysis of components for the development of Trainer Simulators

WORK CONTENT

SOW PAR

Activities include:

- Identification of commercial equipment providing function or crew interface of flight component
- Evaluation/ Assessment of fidelity of commercial equipment
- Development of design drawings for alternate components or modifications to components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the Trainers.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.04

WBS NUMBER

Assembly and Checkout

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Trainers and supporting equipment, and the integration of all subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Assemble parts into components

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Trainers subsystems
- Integration of the Trainers with appropriate test set equipment
- Testing of units to verify compliance with requirements



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.06

WBS NUMBER

Functional Training Support

WBS TITLE

DEFINITION

Maintaining support for operation, repair, refurbishment or upgrade of trainers for mission specific training.

WORK CONTENT

SOW PAR

Activities Include:

- Identification of Mission Specific training Requirements
- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Trainer performance



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.4.4.07

WBS NUMBER

Training Simulator Management Planning and Control

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Trainers development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.4.5.0

WBS NUMBER

Ground Support Equipment

WBS TITLE

DEFINITION

Effort required to develop and control the utilization of GSE during the Furnace Module 1 Development

WORK CONTENT

SOW PAR

Development of Furnace Module 1 GSE.
Scheduling and Management Planning of GSE.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.4.5.1

WBS NUMBER

Ground Support Equipment (GSE) Development

WBS TITLE

DEFINITION

This Effort develops or procures GSE required to support testing, assembly integration, and checkout operations for the Flight, DTA, and GCEL activities.

WORK CONTENT

SOW PAR

Activities include:

- Development of Interface and Resource Simulators
- Handling GSE
- Special Test GSE
- Special Tooling GSE
- Management



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.4.5.2

WBS NUMBER

GSE Management Planning and Control

WBS TITLE

DEFINITION

Effort to plan the utilization and scheduling of GSE between the separate development efforts on the Furnace Module 1.

WORK CONTENT

SOW PAR

Development of utilization schedules
Logistical Analysis
Development of Maintenance plan
Development of operation manuals
Logging and tracking GSE usage.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

4

WBS LEVEL

1.5.0.0

WBS NUMBER

Furnace Module 2 Design, Development, Test and Engineering

WBS TITLE

DEFINITION

The Design, Development, Test, and Engineering (DDT&E) element will include the activities required to design, manufacture, procure, verify and test the SSFF hardware and software and provide continuing support for Integration and Operations.

WORK CONTENT

SOW PAR

Activities incorporated into this element include:

- Design requirements review
- Interface definition review and support
- Concept identification
- Concept trade studies and selection
- SSFF design
- Ground Support Equipment (GSE) identification and design
- Test equipment identification and design
- Training equipment design
- Design support documentation preparation
- Support facilities requirements identification
- Manufacturing activities and support
- Procurement activities and support
- Testing activities and support
- Analytical integration support
- Physical integration support
- Flight and mission operations support
- Verification activities
- Review support

Deliverables:

- GSE Test Sets
- 2 Test Articles
- 3 Ground Control Experiment Laboratory (GCEL) Units
- Flight Unit.
- 3 Training Simulators



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.5.1

WBS NUMBER

Test Article Development

WBS TITLE

DEFINITION

The development of the Test Article hardware and software is required to demonstrate the technological design approach for the Furnace Module 2 Flight Unit, including interface compatibility and equipment functionality.

WORK CONTENT

SOW PAR

Activities Include:

- Systems Engineering Analyses of Furnace Module 2 Engineering Design
- Modification/redesign of furnace flight designs for DTA application
- Fabrication and Assembly and/or Procurement of SSFF DTA Components.
- Assembly and Integration of the DTA components and systems
- Testing of the DTA components and Integrated DTA system.
- Functional Checkout of DTA system
- Management

Deliverable:

2 Test Articles
GSE Sets



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analyses activities to the review of components identified as part of the preliminary design input for the PDR, and determine appropriate modifications for application to DTA.

WORK CONTENT

SOW PAR

Engineering Analyses include:

- Definition of Operating requirements and environment for each component.
- Review function of each component
- Researching the capabilities of off-the-shelf equipment
- Select substitute commercial components
- Generation of functional block diagrams and schematics
- Performing cursory analyses of Test Article component configuration
- Identify components requiring redesign



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.02

WBS NUMBER

Design Modification/Redesign

WBS TITLE

DEFINITION

The actual design modification or redesign analyses of the Flight Unit design input and the generation of drawings to support the development of components required to make the Test Article.

WORK CONTENT

SOW PAR

Design activities include:

- Review of requirements for component function
- Generation of component design drawings
- Development of support structure drawings
- Modification of existing design drawings
- Generation of assembly and integration drawings



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

The review of drawings developed through the design modification or redesign activities, development of fabrication plans including the identification of quality inspection points, and the actual fabrication of the components for the DTA. The manufacturing activities will begin after the PDR and after receiving approval from NASA.

WORK CONTENT

SOW PAR

Activites include:

- Requisition of off-the-shelf equipment
- Evaluation of the required components for functionality and physical interface agreement
- Interfacing with the designers in the event that the commercial component identified is not available
- Red line/modify design drawings
- Procure raw materials
- Develop Fabrication plans
- Develop quality inspect procedures.
- Fabricate each part



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.04

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Test Article and supporting equipment, and the integration of all Test Article subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Test Article subsystems
- Integration of the Test Article with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.05

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Performance confirmation testing and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the Test Article assembly. The identification of appropriate facilities, whether in-house or subcontractor facilities, to conduct the testing activities will be required. These testing activities will require the use of GSE test sets, which will be designed and developed in parallel with the Test Article components, and will take into account the Test Article use environment and available resources.

WORK CONTENT

SOW PAR

Testing activities include:

- Verification of fabricated and procured items
- Testing to verify component operation within designed or advertised specifications in their intended use environments
- Testing of subsystem for intended use environments



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.06

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the Test Article system equipment for evaluation of the functional performance of all components planned for use in the Flight Unit design, and the identification of design improvements.

WORK CONTENT

SOW PAR

Functional Checkout includes:

- Operation and monitoring of all subsystems
- Acquiring functional performance data of DTA systems and components
- Data reduction and analysis



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.1.07

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Test Article development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.1.08

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during DTA operation and testing.

WORK CONTENT

SOW PAR

Activities Include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of DTA performance
- Support the configuring of the DTA for selected experiments



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2

WBS NUMBER

Ground Control Experiment Laboratory (GCEL) Development

WBS TITLE

DEFINITION

The development of the Furnace Module 2 Ground Control Experiment Laboratory (GCEL) hardware and software is required for qualification activities, to provide Furnace Module 2 capabilities and flight identical interfaces as simulation GSE for FM GCEL hardware and software, and to perform parallel ground operation of the on-orbit Flight Unit hardware and software.

WORK CONTENT

SOW PAR

Activities include:

- Engineering analyses
- Manufacturing
- Procurement
- Assembly and integration
- Component and assembly testing
- Management planning
- Functional checkout activities
- Sustaining Engineering

Deliverables

- 3 GCELs



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.01

WBS NUMBER

Engineering Analyses

WBS TITLE

DEFINITION

Engineering analysis consists of the activities required to review the Furnace Module 2 CDR design drawings and determine requirements for GCEL development and testing.

WORK CONTENT

SOW PAR

Engineering analyses activities will include:

- Review of components identified as the critical design input
- Review of the function of each of these components in their intended use environment
- Identification of component physical qualification testing
- Providing analyses to the development of qualification test plans.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the GCEL after a review of the engineering design derived from the CDR input.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Furnace GCEL and supporting equipment, and the integration of all Furnace GCEL subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the GCEL subsystems
- Integration of the GCEL assembly with appropriate test set equipment



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the GCEL assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Furnace Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities
- Test components within designed or advertised specifications
- Evaluate component and system performance for GCEL application.
- Perform qualification testing on GCEL for flight environment.
- Compile test data for verification of interfaces.



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.07

WBS NUMBER

Functional Checkout

WBS TITLE

DEFINITION

Operation of the GCEL to simulate flight operations to evaluate system performance of the flight design.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Operation of the GCEL system equipment
- Evaluation of the GCEL performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.2.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the Furnace Module 2 GCEL development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

The schedule preparation activities involve:

- Reviewing the GCEL development activities requirements
- Schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
- Developing facilities usage schedules



**TELEDYNE
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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.2.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during GCEL operation and testing.

WORK CONTENT

SOW PAR

Activities Include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of GCEL performance
- Support to GCEL operations during PI ground control experiment operation



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.5.3

WBS NUMBER

Furnace Module 2 Flight Unit

WBS TITLE

DEFINITION

Development of the Flight hardware and support of the integration and delivery of the Furnace Module 2.

WORK CONTENT

SOW PAR

Activities Includes:

Review of Requirements
Development of Preliminary Design Input for DTA.
Development of Critical Design Input for GCEL
Manufacture and Procure of flight hardware
Testing for acceptance and verification.
Sustaining Engineering through integration and operations.
Management planning

Deliverables:

1 Flight Unit
Spares



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Effort to begin the detailed analyses of the chosen subsystems, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, FM developers, and the science community planning to use the SSFF (i.e., the Principal Investigators (PIs)).

WORK CONTENT

SOW PAR

Activities include:

- Reviewing inputs from schematics and documentation
- Developing functional interface block diagrams and schematics
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.3.02

WBS NUMBER

Preliminary Design

WBS TITLE

DEFINITION

The Preliminary Design activity initiates the development of parts drawings, assembly drawings, and the subsequent design analyses documentation of the selected furnace concept.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated per the IROP document will include the following deliverables for the PDR as a minimum:

- Preliminary Engineering Analyses
- Design Engineering and Analyses
- Analytical Integration Documentation Support
- Facilities Requirements Identification
- Ground Support Equipment (GSE) Requirements Identification
- Phase O/I Safety Analyses and Documentation
- Preliminary Design Review Support
- Phased Safety Documentation for Formal Safety Review
- Software Requirements Document
- Verification Planning Documentation



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.03

WBS NUMBER

Critical Design

WBS TITLE

DEFINITION

The Critical Design Analyses and Documentation Preparation for the Furnace Module 2 is the effort to finalize the detailed analyses of the chosen design approach, and to document the analyses for evaluation and review by the SSFP, NASA Program Management, Core Developer, and the PIs at the CDR. These design inputs will either be updates to documentation submitted at the PDR, or new inputs.

WORK CONTENT

SOW PAR

The analyses and subsequent documentation required to be generated per the IROP document will include the following deliverables for the CDR as a minimum:

- Baseline Issue Parts Drawings
- Baseline Issue Assembly and Integration Drawings
- Latest Quarterly Update of Mass Properties Report
- Final Materials Identification and Usage List
- Updated Power Profiles
- Baseline Issue Command and Data Management Schematics
- Baseline Issue Electrical Power Interface Schematics
- Updated Structural Analyses Report
- Phase II Safety Packages
- Updated Software Requirements Document
- Baseline Issue Verification Plan
- Detailed Engineering Analyses
- Design Engineering and Analyses (Updates)
- Analytical Integration Documentation Support
- Phase II Safety Analyses and Documentation
- Detailed (Critical) Design Review Support
- Manufacturing
- Procurement
- Phase II Safety Review Support
- Assembly and Integration Support
- Interface Verification Support
 - Analytical
 - Testing



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.3.04

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the Flight Unit from a review of the engineering design.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.05

WBS NUMBER

Assembly and Integration

WBS TITLE

DEFINITION

Assembly and integration activities will include the assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Furnace Flight Unit and supporting equipment, and the integration of all Furnace Flight Unit subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

The Assembly and Integration Activities include:

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets as required for functionality testing
- Integration of the Furnace subsystems
- Integration of the Furnace assembly with appropriate test set equipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.06

WBS NUMBER

Testing

WBS TITLE

DEFINITION

Testing to verify performance confirmation and safe operation proof testing of the fabricated and procured components, the subsystem level assemblies, and ultimately the qualification testing of the Flight Unit assembly. The qualification testing activities will be performed on the GCEL to provide acceptance data for the Flight Unit.

WORK CONTENT

SOW PAR

Testing activities include:

- Identify appropriate facilities
- Test components within designed or advertised specifications
- Evaluate component and system performance
- Perform qualification testing for the flight environment
- Compile test data for verification of interfaces



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.07

WBS NUMBER

Acceptance Testing and Functional Checkout

WBS TITLE

DEFINITION

Testing of GCEL and Flight Unit to verify compliance with the CEI Specification.

WORK CONTENT

SOW PAR

Functional checkout activities will include:

- Evaluation of the Flight Unit performance
- Evaluation of the functional performance of all components
- Data reduction and analysis



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.3.08

WBS NUMBER

Management Planning

WBS TITLE

DEFINITION

Management planning activities for the Furnace Module development will include preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required, the procurement and supervision of facilities and their usage for performing the tasks and activities described, the monitoring of discipline performance for each of the schedules, and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

The schedule preparation activities involve:

- Reviewing the development activities requirements
- Preparing schedules for design, fabrication, assembly, integration, qualification, component performance operations testing, and checkout activities
- Developing facilities usage schedules



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.3.09

WBS NUMBER

Sustaining Engineering Support

WBS TITLE

DEFINITION

Maintaining engineering staff to troubleshoot problems arising during Integration and Operations.

WORK CONTENT

SOW PAR

Activities include:

- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Flight Unit performance
- Support to mission Integration and Operations



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.5.4

WBS NUMBER

Training Simulator Development

WBS TITLE

DEFINITION

Effort to design and develop the Training simulators defined in WBS 1.7.2

WORK CONTENT

SOW PAR

Activities include:

- Review of requirements for trainers
- Engineering Analyses and Design of trainers
- Manufacture and Procurement of trainer components
- Assembly, Integration, and checkout of trainers
- Training support for repair and maintenance
- Management Planning and Control



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.4.01

WBS NUMBER

Requirements Review

WBS TITLE

DEFINITION

Review of training requirements in PTRD.

WORK CONTENT

SOW PAR

- Reviewing inputs from schematics and documentation
- Developing initial Assembly Drawings
- Consolidating requirements for Flight System Components



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SSFF

MISSION

1

WBS LEVEL

1.5.4.02

WBS NUMBER

Design Engineering and Analyses

WBS TITLE

DEFINITION

Design selection and systems engineering analysis of components for the development of Trainer Simulators

WORK CONTENT

SOW PAR

Activities include:

- Identification of commercial equipment providing function or crew interface of flight component
- Evaluation/ Assessment of fidelity of commercial equipment
- Development of design drawings for alternate components or modifications to components



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.4.03

WBS NUMBER

Manufacturing and Procurement

WBS TITLE

DEFINITION

Purchasing raw materials and selected components and fabrication of the parts and components for the Trainers.

WORK CONTENT

SOW PAR

Manufacturing activities will include:

- Review of the updated drawings
- Development of fabrication plans
- Identification of quality inspection points
- Fabrication of the components

Procurement activities will include:

- Research and selection of acceptable equipment and/or equipment subcontractors
- Purchasing of raw materials and components
- Receiving inspecting and inventoring materials



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.4.04

WBS NUMBER

Assembly and Checkout

WBS TITLE

DEFINITION

Assembly of fabricated and procured components into subassemblies or subsystem assemblies for the Trainers and supporting equipment, and the integration of all subassemblies and/or subsystem assemblies into the supporting structural equipment and into appropriate special test equipment.

WORK CONTENT

SOW PAR

Assemble parts into components

- Assemble components into subsystems
- Integration of subsystems into appropriate test sets
- Integration of the Trainers subsystems
- Integration of the Trainers with appropriate test set equipment
- Testing of units to verify compliance with requirements



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.4.06

WBS NUMBER

Functional Training Support

WBS TITLE

DEFINITION

Maintaining support for operation, repair, refurbishment or upgrade of trainers for mission specific training.

WORK CONTENT

SOW PAR

Activities include:

- Identification of Mission Specific training Requirements
- Review of component performance
- Identification of alternate component design
- Design of modifications to components for repair or enhancement of Trainer performance



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

1

WBS LEVEL

1.5.4.07

WBS NUMBER

Training Simulator Management Planning and Control

WBS TITLE

DEFINITION

Preparation of schedules for the design, fabrication and procurement, testing, assembly and integration, and the functional checkout activities required; the procurement and supervision of facilities and their usage for performing the tasks and activities described; the monitoring of discipline performance for each of the schedules; and the evaluation of discipline performance for improvement and cost reduction.

WORK CONTENT

SOW PAR

Activities include:

- Reviewing the Trainers development activities requirements
- Developing subsystem level schedules required for the design, fabrication, assembly and integration, testing, and checkout activities
- Development of facilities usage schedules for each of the required facilities
- Monitoring and evaluation of discipline performance.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.5.5.0

WBS NUMBER

Ground Support Equipment

WBS TITLE

DEFINITION

Effort required to develop and control the utilization of GSE during the Furnace Module 2 Development

WORK CONTENT

SOW PAR

Development of Furnace Module 2 GSE.
Scheduling and Management Planning of GSE.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.5.5.1

WBS NUMBER

Ground Support Equipment (GSE) Development

WBS TITLE

DEFINITION

This Effort develops or procures GSE required to support testing, assembly integration, and checkout operations for the Flight, DTA, and GCEL activities.

WORK CONTENT

SOW PAR

Activities include:

- Development of Interface and Resource Simulators
- Handling GSE
- Special Test GSE
- Special Tooling GSE
- Management



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

6

WBS LEVEL

1.5.5.2

WBS NUMBER

GSE Management Planning and Control

WBS TITLE

DEFINITION

Effort to plan the utilization and scheduling of GSE between the separate development efforts on the Furnace Module 2.

WORK CONTENT

SOW PAR

Development of utilization schedules
Logistical Analysis
Development of Maintenance plan
Development of operation manuals
Logging and tracking GSE usage



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SSFF

MISSION

4

WBS LEVEL

1.6

WBS NUMBER

Integration

WBS TITLE

DEFINITION

Provide the effort to analyze each SSFF element and synthesize these requirements into a viable mission for the Space Station Freedom.

WORK CONTENT

SOW PAR

This WBS element contains:

- Support of Analytical Integration into the SSFF
- Physical integration of the SSFF into a flight rack configuration
- Support of the physical integration of the rack into the mission element of the SSF



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.6.1

WBS NUMBER

Analytical Integration

WBS TITLE

DEFINITION

Provide the effort to analyze the SSFF and generate the required data inputs for SSF as required by IROP for a pre-integrated rack payload.

WORK CONTENT

SOW PAR

Activities include:

- Configuration Design Definition to perform analyses that define the payload configuration layout
- Provide interface and functional definition data for interfaces to SSF Data Management System, Electrical Power System, Gaseous Nitrogen System, Vacuum Vent System, and Thermal Control System.



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SSFF

MISSION

5

WBS LEVEL

1.6.2

WBS NUMBER

Physical Integration

WBS TITLE

DEFINITION

Provide the additional effort, equipment, and materials to meet the SSF criteria for a pre-integrated payload.

WORK CONTENT

SOW PAR

Activities include:

- SSFF Core Assembly and Integration
- Furnace Module 1 Assembly and Integration
- Furnace Module 2 Assembly and Integration
- Interface Test Verification
- Pre-Integrated Payload Packaging and Shipment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

WBS LEVEL

1.7

WBS NUMBER

Facility Operations Training

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principle Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

This WBS has the following subelements:

- Develop Training
- Define requiremetns for trainers
- Conduct Training
- Manage Training



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.7.1

WBS NUMBER

Develop Training

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principle Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

- Perform training requirements analysis to determine target populations, training needs, trainer quantity, functionality, and fidelity, and validation of the analysis.
- Prepare training inputs for the Integrated Requirements On Payloads (IROP)
- Prepare and maintain User Payload Training Plan (UPTP)
 - Analyze mission operations, facility training requirements, and training objectives
- Document Requirements
- Update IROP inputs based on the UPTP requirements
- Review and Negotiate the PIA Training Annex with SSFP personnel
 - a. Analyze mission operations, facility training requirements, and training objectives for SSFF.
 - b. Participate in meetings and reviews of the PIA Training Annex to resolve any conflicts and come to a final agreement
- Participate in the SSFF CDR to evaluate training requirements for the UPTP, IROP, PIA Training Annex, and PTRDs
- Develop SSFF Increment Independent training courses and courseware
 - a. Analyze SSFF operations and training objectives
 - b. Document Requirements



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.7.1

WBS NUMBER

Develop Training

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principle Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

- Develop SSFF Increment Dependent training courses and courseware
 - a. Analyze SSFF operations and training objectives
 - b. Document Requirements
- Conduct Training Acceptance Reviews on the Training developed
- Participate in the SSFF FOR to evaluate training requirements for the UPTP, IROP, PIA Training Annex, and PTRDs.
- Develop SSFF training to be utilized in the PTC
 - a. Analyze inputs required for development of SSFF training performed in the PTC.
 - b. Document Requirements
- Deliverables
 - a. User Payload Training Plan
 - b. Training Instructor Guides
 - c. PTC Training Scenarios



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.7.2

WBS NUMBER

Define Trainers

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principle Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

01. Develop Payload Trainer Requirements Document Part I (PTRD Part I)
 - a. Analyze required inputs for the development of the PTRD Part I
 - b. Document Requirements
 1. Define operations to be supported
 2. Define structures and components
 3. Define fidelity of each component
 4. Define training objectives
 5. Define verification/validation methodology
 6. Define trainer requisition, storage, and logistical responsibilities
 7. Define operations between SSFF core and Furnace Module trainers (if any)
02. Develop Payload Trainer Requirements Document Part II (PTRD Part II)
03. Develop Acceptance Test Procedures to ensure the payload simulator meets the requirements levied in the PTRD
04. Conduct concurrent verification analysis for the payload trainer.
05. Provide support to the PTC during integration and checkout of the SSFF trainer into the PTC.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.7.2

WBS NUMBER

Define Trainers

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principle Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

- 06. GFP Input Requirements
 - a. Access to the PTC with its classroom, training systems, video system, communication system, computer operating system, and support personnel
 - b. Access to the SSFF IOF with its classroom, video system, communication system, payload trainer, computer operating system, and support personnel
- 07. Deliverables
 - a. Payload Trainer Requirements Documents
 - b. Acceptance Test Procedures and Reports



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.7.3

WBS NUMBER

Training Execution

WBS TITLE

DEFINITION

Provide the manpower and associated services required to support and accomplish training of the Crew, POIC Cadre, SSFF GSP, Principal Investigators (PIs), and Payload Element Developers (PEDs) to conduct operations for the Space Station Furnace Facility during Man-tended and Ground-tended phases of the Space Station Freedom operations.

WORK CONTENT

SOW PAR

01. Conduct training to ensure Instructors are adequately prepared to perform the role of SSFF instructor.
02. Conduct the following types of training utilizing the training courses and courseware previously developed:
 - a. Science Background
 - b. Individual Payload
 - c. Proficiency Training
 - d. Safety Training
 - e. PTC Training (as required)
03. Attend training required and conducted by SSFP/POIF
04. Provide technical/operational expertise on the SSFF trainer to the PTC during training and simulations
05. GFP Input requirements
 - a. SSFP Training documentation
 - b. E/FRD
 - c. IROP
 - d. Access to the PTC with its classroom, training systems, video system, communication system, computer operating system, and support personnel
 - e. Access to the SSFF IOF with its classroom, training systems, video system, communication system, computer operating system, and support personnel
 - f. Access to the POIC and UOA with its computer operating system (for POIC terminal training and OMIS training.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

4

WBS LEVEL

1.8.0

WBS NUMBER

Mission Operations

WBS TITLE

DEFINITION

Effort to plan for and support the operation of the SSFF.

WORK CONTENT

SOW PAR

Activities include:

Managing all operations support.
Planning the operations of the SSFF.
Attending training and simulations to become familiar with operational procedures.
Staffing the Operations Center during SSFF operating periods.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.8.1

WBS NUMBER

Operations Management

WBS TITLE

DEFINITION

Effort to supervise and evaluate the performance of Mission Operations activities.

WORK CONTENT

SOW PAR

- Performance Management and Administration performs the planning and control, performance assessment, and produce assurance for the operations function.
 - a. Management services performs the accounting, staffing, and travel management function.
 - b. Performance assessment provides the planning, costing, and scheduling for all operations tasks.
- Information management provides information assessment and product assurance functions.
 - a. Management services performs accounting, staffing, and travel administration.
 - b. Performance assessment provides planning, costing, scheduling, tracking, and reporting of operations tasks.
- Information Management provides information identification, preparation, control, delivery, archiving, and retrieval or operations documentation. Reproduction and graphics support for
 - a. SSF reviews (RR, PDR, CDR, and FOR)
 - b. Action item tracking and document control for operations functions.
- Special Studies are performance in support of pre-increment definition or other support for flight operations.
- Productivity Improvement activities will be implemented over the course of the operations design and development and operations execution.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.8.2

WBS NUMBER

Operations Planning

WBS TITLE

DEFINITION

Effort to identify facility, hardware, software, and personnel requirements for performing Mission Operations activities.

WORK CONTENT

SOW PAR

- Develop an operations timeline that defines the allocation of crew, ground support, and SSF resources.
- Develop operations software requirements for both flight and ground computer systems
- Develop ground operations facility requirements
- Plan, prepare, and execute the verification of the SSFF ground facilities
- Perform all aspects of data management analysis and data return planning
- Define the Data Processing Requirements for SSFF
- Provide operations input to the development and verification of the Telemetry/Command Database
 - a. Analyze and define the operations parameters for the Master Objective Data Base (MODB)
 - b. Coordinate with all operations data users to ensure adequate telemetry/command data points are accessible for operations.
- Plan and develop the composition of the SSFF operations team
 - a. Define the operations tasks for the following team members: Facility Manager, Staff Scientist, Systems Engineer, Software/Data System Engineer(s), Activity Planner/Technician
 - b. Participate in pre-mission planning activities with corresponding positions within the POIC and other control centers active in the integrated mission.



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.8.3

WBS NUMBER

Operations Training

WBS TITLE

DEFINITION

Effort to attend training courses on SSF operations procedure.

WORK CONTENT

SOW PAR

Develop operations inputs to training requirements documents

Provide personnel to receive training on operations tools and techniques required to function in the SSF/Orbiter operations environment



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.8.4

WBS NUMBER

Operations Execution

WBS TITLE

DEFINITION

Effort to staff and operate the SSFF Operations Center.

WORK CONTENT

SOW PAR

Provide a trained SSFF operations team prepared to support pre-mission Level III/II and Level IV Mission Sequence Tests.

Support integrated mission simulations as required by relevant operations organizations (SSF, POIC, etc.).

Provide on-going flight operations support for the control and monitoring of the health and safety of the SSFF, mission planning/replanning and anomaly investigation. The following functional areas will be supported:

- a. Definition of operational and science priorities
- b. Coordination with other relevant operations organizations
- c. Plan and conduct quick look science evaluations
- d. Input to planning/replanning activities (timelines)
- e. Health and safety monitoring
- f. Anomaly investigation
- g. Data flow configuration and accounting



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

4

WBS LEVEL

1.9.0

WBS NUMBER

Logistics Identification and Definition

WBS TITLE

DEFINITION

The activities associated with planning, monitoring, and overseeing the transfer of GSE, DTAs, GCEs and flight equipment between the various development efforts comprising the SSFF Program.

WORK CONTENT

SOW PAR

Activities include:

- Management, planning, and control of SSFF Program Logistics
- Identification of Logistics requirements for the Core
- Identification of Logistics requirements for Furnace Module 1
- Identification of Logistics requirements for Furnace Module 2



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.9.1

WBS NUMBER

Logistics Management Planning and Control

WBS TITLE

DEFINITION

Effort required to plan and control the implementation logistical transfer of equipment between the various development and test sites of the SSFF Program.

WORK CONTENT

SOW PAR

Activities include:

- Developing hardware utilization schedules
- Identifying transportation requirements
- Reviewing shipping and inspection procedures
- Reviewing operation and maintenance plans



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WORK BREAKDOWN STRUCTURE DICTIONARY

SSFF

MISSION

5

WBS LEVEL

1.9.2

WBS NUMBER

SSFF Core Logistics Requirements Identification

WBS TITLE

DEFINITION

Effort to identify the maintenance and upgrading of facility required for interface, functional, and verification testing of the SSFF Core

WORK CONTENT

SOW PAR

Activities include:

- Subsystem level components and ORU analyses
- Definition and analyses of supply requirements
- Definition and analyses of maintenance requirements
- Definition and of transportation, handling, packaging and storage requirements
- Definition of prelaunch requirements
- Definition of post-launch requirements